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NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
SPRING POND DAM MA 00. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV DEC 78

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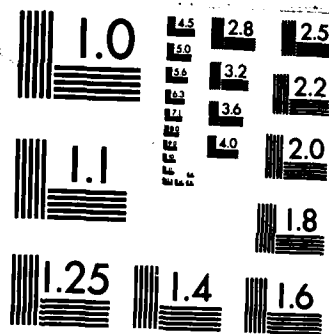
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FINAL
NORTH RIVER BASIN
PEABODY, MASSACHUSETTS

(2)
FOUNDATIONS & MATERIALS
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**SPRING POND DAM
MA 00193**

**PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) ~Spring Pond Dam is an earthfill embankment with a maximum height of about 10 feet and a relatively straight crest about 225 feet long, averaging about 20 feet wide. The dam is considered to be in good condition. The dam is classified as small in size with a significant hazard potential.		

**SPRING POND DAM
MA 00193**

**NORTH RIVER BASIN
PEABODY, MASSACHUSETTS**

**PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**

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**NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT**

Identification No.:	MA 00193
Name of Dam:	SPRING POND DAM
Town:	PEABODY
County:	ESSEX
State:	MASSACHUSETTS
Stream:	TAPLEY BROOK
Date of Inspection:	16 NOVEMBER 1978

BRIEF ASSESSMENT

Spring Pond Dam is an earthfill embankment with a maximum height of about 10 feet and a relatively straight crest about 225 feet long, averaging about 20 feet wide. A cast iron pipe and stone masonry structure combine to form an outlet-spillway located about 25 feet from the left end of the embankment. The outlet pipe, 30 inches in diameter, about 50 feet long, passes under the base of the dam and leads to the stone masonry structure which forms a spillway. Discharges over the spillway are controlled by a weir consisting of 3 feet long flashboards which can be manually adjusted to the full height of the structure. The freeboard without the flashboards is 10.5 feet. Presently the spillway is covered by steel plates set on an old gatehouse floor. Access to the flashboards is provided by a steel door which is flush with the plates. Flow over the spillway is discharged into Fountain Pond located at the downstream toe of the dam.

Fountain Pond (also known as Lower Spring Pond) is used as a storage pond for a water supply pumping station located at the downstream end of Fountain Pond. Discharges from Fountain Pond are into Tapley Brook, North River and finally into Beverly Harbor.

Phase I inspection and evaluation of the Spring Pond Dam does not indicate conditions which would constitute an immediate hazard to human life or property. Based on engineering judgment, as well as, performance of the earth embankment and the outlet works, the project is considered to be in good condition. The project has a number of deficiencies which, if not remedied, have the potential for developing into hazardous conditions.

Because there are no data on Probable Maximum Flood (PMF) for such a small drainage area, it was necessary to synthesize a test flood hydrograph for the contributing area.

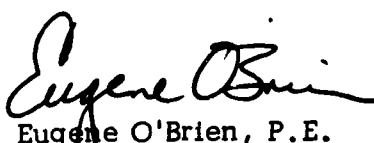
Since the dam is classified as small in size, with a significant hazard potential, the test flood, in accordance with Corps of Engineers' guidelines, is between the 100-year flood to one half the Probable Maximum Flood (1/2 PMF). The Test Flood hydrographs, based on the 100 year flood and 1/2 PMF result in peak inflows of 584 cfs (1335 csm) and 1093 cfs (2498 csm), respectively. The 100 year flood was selected as the Test Flood.

The adequacy of the spillway was tested by routing the Test Flood through the reservoir using a computer routing technique. The water surface was assumed to be at the normal pool level (El 68.7) at the start of the storm. The resulting peak outflow for the 100 year flood was 78 cfs corresponding to El 69.98 or 0.25 feet below the crest of the dam. It is estimated that 39% of the PMF over the drainage area could be processed by the Spring Pond spillway without overtopping the dam.

Since the dam is not expected to be overtopped with an inflow equal to the 100 year flood, it is considered that the spillway is adequate from a hydraulic and hydrologic standpoint. Therefore, no further investigations and/or recommendations are considered necessary at this time.

Remedial measures, however, are recommended for implementation by the owner within 24 months of receipt of this Phase I Inspection Report to improve overall conditions. These measures, in general, are as follows:

- Repairs to embankment and appurtenant structures
- Programs for operation, maintenance and inspection.


Eugene O'Brien, P.E.
New York No. 29823

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

NORTH RIVER BASIN
SPRING POND DAM
INVENTORY NO. MA 00193
PHASE I INSPECTION REPORT

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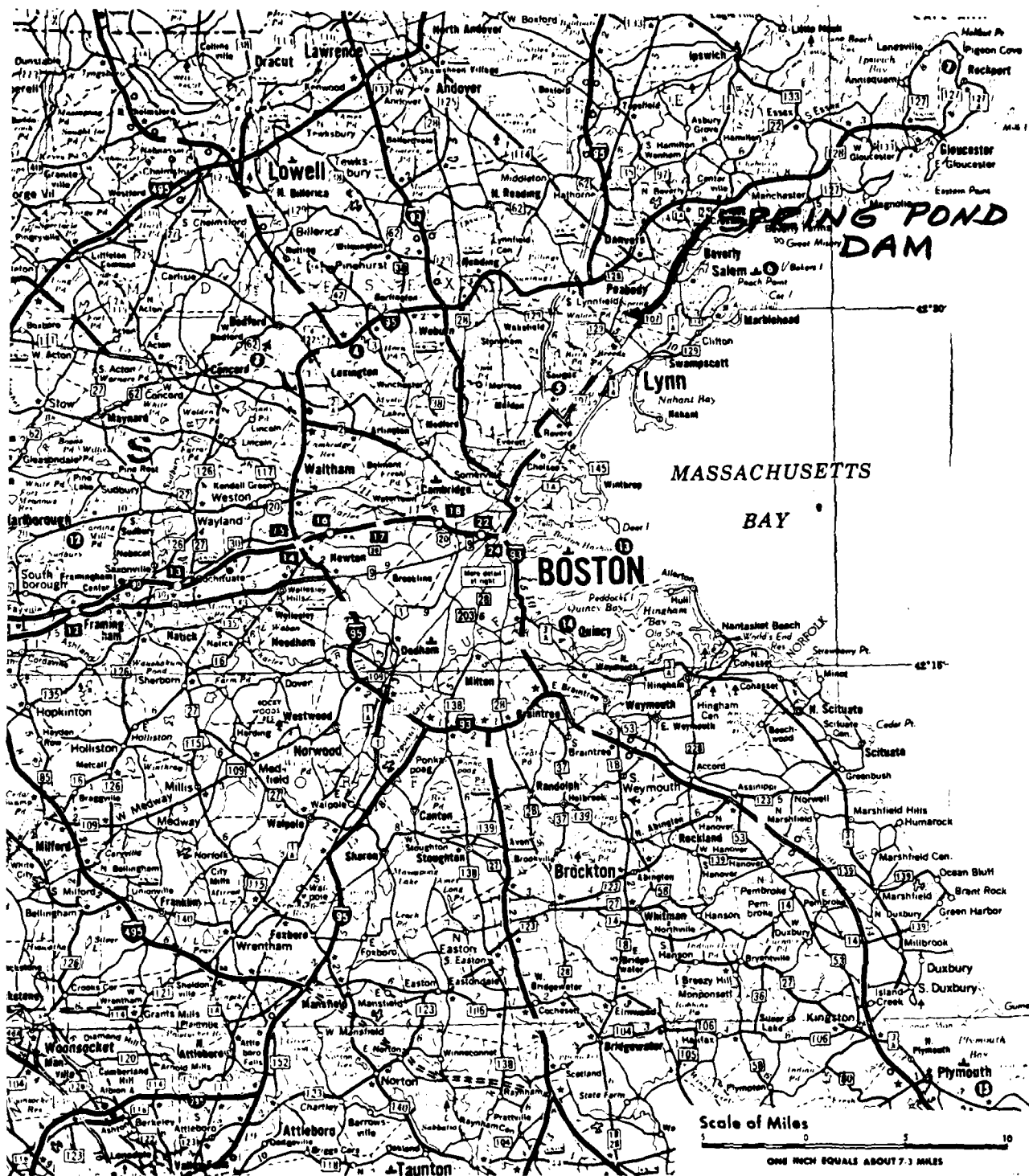
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- A. VISUAL INSPECTION CHECKLIST
- B. DRAWINGS AND INSPECTION REPORTS
 - 1. Peabody Dams 1932-1938 Sheet 1 of 1
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- E. INFORMATION AS CONTAINED IN THE NATIONAL
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1. GENERAL OVERVIEW OF DAM.



VICINITY MAP
SPRING POND OUTLET DAM

SALEM AND LYNN, MASS. QUADRANGLES
SCALE: 1 IN. = 2000 FT.



TOPOGRAPHIC MAP
SPRING POND OUTLET DAM

1. The water level of Spring Pond would be at El 68.7 before the Test Flood occurrences. This elevation, made possible by placing flashboards, reportedly permits maximum desirable storage. Above this level a flood condition exists.
2. At the beginning of the test occurrence the Fountain Pond level would be at El 61.58 and Spring Pond flashboards will be removed to allow for maximum discharge condition for the outlet-spillway.
3. Inflow transfer from Suntaug Lake is assumed to be discontinued during the Test Flood occurrences.

On the basis of the above assumptions the 100-year flood when routed through the Pond's storage as obtained from topographic information^{5/} would result in a maximum water level to El 69.98, or 0.25 feet below the top of the dam. The maximum discharge corresponding to this level is 78 cfs. The 1/2 PMF would result in a maximum pond level to El 70.50 corresponding to a discharge of 469 cfs or 0.27 feet above the dam crest. In this case, 81 cfs would flow through the outlet-spillway and the remainder over the dam. It is estimated that 39 percent of the PMF would be processed by the structure without overtopping the dam.

Considering that the 100-year Test flood would pass through the outlet-spillway without the pond level exceeding that of the dam crest, the present structure appears adequate from the hydrologic and hydraulic point of view.

References

- 1/ "National Program of Inspection of Dams", Department of the Army, Office of the Chief of Engineers, Washington, D.C. 20314, May 1975.
- 2/ "Recommended Guidelines for Safety Inspection of Dams", Department of the Army, Office of the Chief of Engineers, Washington, D.C. 20314.
- 3/ "Rainfall Frequency Atlas of the United States", USWB Technical Paper, No. 40.
- 4/ Engineer Circular EC 110-2-27, August 1, 1966.
- 5/ U.S.G.S. Quadrangles Lynn, Mass., 1970 and Salem, Mass., 1970.

breach of Spring Pond Dam would endanger the power transmission towers located on it, a housing development on the west bank of Fountain Pond, the pumping station which supplies 80 percent of the City's water supply, the Cedar Grove cemetery and possibly the bridge at Cemetery Road.

The potential hazard was evaluated using the Corps of Engineers "Rule of Thumb for Estimating Downstream Dam Failure Hydrographs" as follows: A breach equivalent to 40 percent of the dam length (90 feet) and a channel roughness of 0.07 were assumed. The hypothetical flood wave height was estimated at locations 850, 220 and 3930 feet downstream from the dam. The following results were obtained:

<u>Distance from Dam (ft)</u>	<u>Wave Height (ft)</u>	<u>Flood Elev(ft)</u>	<u>Flood Discharge(cfs)</u>
850	5.1	61.1	4820
2200	6.7	63.7	4048
3930	5.4	52.4	3690

According to the above estimates several houses on the west shore of Fountain Pond would be inundated with water up to 3.7 feet deep. Accordingly, the hazard would be significant. Because the dam is classified as small in size, with a significant hazard potential, the test flood in accordance with Corps of Engineers guidelines is between the 100-year flood and one half the Probable Maximum Flood (1/2 PMF). The 100 year flood is selected as the test flood. The 100-year precipitation for Peabody, Massachusetts, is 4.75 inches in 6-hours. ^{2/} Assuming losses to be negligible, the volume of the 100-year flood would be 110.8 acre feet, corresponding to less than a 2 foot rise of lake level, if no outflow is assumed. The Test Flood hydrograph constructed to represent instantaneous conversion to runoff has a peak of 584 cfs (1335 cms). The Maximum Probable Precipitation (PMP) for the area is 23.4 inches ^{3/} for a 6-hour rainfall over a 10-square mile area. With adjustment for conformity of the generalized isohyets (in Reference 3) with the water shed shape ^{4/} the effective PMP becomes 18.72 inches. Applying losses at 0.2 inches per hour for the land area (78 percent of the total) the resulting runoff equivalent to the PMF is 17.78 inches over the entire watershed. The volume of the 1/2 PMF would be 207.4 acre-feet. The flood hydrograph for the 1/2 PMF constructed to represent instantaneous conversion of rainfall to runoff has a peak of 1093 cfs (2498 csm).

The adequacy of the outlet-spillway was tested by routing both Floods through the reservoir using a computer routing technique. The following assumptions were made for the routing of the Floods.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

No design data are available. Spring Pond is located on Tapley Brook and its watershed is adjacent to the watersheds of Frog Pond to the south, and Browns Pond to the east. Spring Pond which reportedly is supplied through a tunnel-and-pipe connection from Suntaug Lake, discharges to the north into Fountain Pond and subsequently into Sidney's Pond. Further downstream Tapley Brook joins Goldthwait Brook which flows through Peabody and into the North River and then Beverly Harbor. The drainage area of Spring Pond is 280 acres (0.44 square miles) of which about 22 percent is occupied by the Pond. Most of the land area is adjacent to the east shore and only a small portion of the area is drained by a short tributary with a defined channel. Inasmuch as more than 50 percent of the runoff from the entire watershed would enter the pond without significant lag time the Test Flood considered herein is assumed to be an instantaneous conversion of rainfall increments into corresponding runoff rates.

b. Experience Data

It is reported by persons interviewed that to their knowledge the dam has never been overtopped. The maximum recorded elevation of the Pond within the last 15 years was on May 12, 1977 to El 68.74. This elevation was attained by a controlled flow through the aqueduct from Suntaug Lake and not as a result of a storm.

c. Visual Inspection

At the time of the inspection, the Pond level was about 4 feet below the top of the dam with about 40 inches of flashboard in place. The spillway and training walls were in generally good condition. There is no downstream channel as Fountain Pond is located at the downstream toe of the dam.

For further details see Section 3.1c.

d. Overtopping Potential

The dam height and the reported maximum impoundment ^{1/} place the dam in the "small" size category. The land adjacent to Fountain Pond, into which Spring Pond discharges, is densely inhabited. A hypothetical

* Numbers denote references listed at the end of the Section.

SECTION 4 - OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

Operating procedures for the project are not formally established but are based on the experience of the operating personnel.

4.2 MAINTENANCE OF DAM

There is no formal maintenance manual for the project. It is reported that maintenance is carried out as needed. There is no scheduled program of inspection by the owner, however, personnel from the pumping station do "look at" the dam when they adjust the flashboards daily. It is reported that the vegetation on the embankment is cut once or twice a year. Although the State has a program of dam inspection since 1968, it is reported that Spring Pond Dam has not been inspected under this program. Prior to 1968, Essex County conducted inspections from 1912 to 1968 and a summary of their inspection reports is given in the Appendix.

4.3 MAINTENANCE OF OPERATING FACILITIES

There is no established maintenance program for the operating facilities. Maintenance is carried out as needed.

4.4 WARNING SYSTEMS IN EFFECT

There is no warning system in effect.

4.5 EVALUATION

The maintenance and operating procedures for the dam and appurtenant structure are, in some respects, deficient. Measures to improve these deficiencies are given in Section 7.

inches of concrete which is in good condition. At the time of inspection there were about 40 inches of flashboard in place and the flow was over the flashboards. The condition of the intake pipe could not be determined because it was underwater.

d. Abutments

There were no signs of seepage or other unusual conditions at the abutments. The right abutment slope, in the vicinity of the spillway, is riprapped for about 50 feet and in generally good condition.

e. Downstream Channel

There is no downstream channel as Fountain Pond is located at the downstream toe of the dam.

f. Reservoir Area

In the vicinity of the dam there is no evidence of sloughing or potentially unstable slopes which could adversely affect the dam.

3.2 EVALUATION OF OBSERVATIONS

Visual observations made during the course of the investigation revealed several deficiencies which at present do not adversely affect the adequacy of the dam. However, these deficiencies do require attention and should be corrected before further deterioration leads to a hazardous condition. Recommended measures to improve these conditions are given in Section 7.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

A visual inspection of Spring Pond was made on 16 November 1978. The weather was sunny, temperature between 50° and 60°F. The last rainfall reportedly occurred 2 weeks before the inspection. At the time of the inspection the Pond level was about 4 feet below the top of the dam.

b. Embankment

The earth embankment appears to be in generally good condition. The horizontal alignment of the crest is generally good and the vertical alignment is also good except for some depressions and ruts which have been created by traffic, especially trail bikes. (See Photograph No. 2). There is a high voltage transmission tower and a telephone pole located on the crest of the embankment. (See Photograph No. 2). Several concrete blocks were observed on the crest. It is reported that these will be placed, at some future date, on the upstream slope as additional slope protection. (See Photograph No. 2).

The upstream slope is in generally good condition. The cemented riprap is in good condition, however, the cemented section of riprap extends only little more than half way along the length of the embankment. The remainder of the slope protection consists of uncemented riprap. In this area some stone is missing, and others have been displaced. There are saplings, tall weeds, brush and grass growing through the riprap. (See Photograph No. 3). Two 8-inch diameter pipes located on either side of and parallel to the spillway and about one foot below the dam crest were observed. Reportedly these pipes had been used as overflow pipes but have since been plugged.

The downstream slope is in generally good condition except that there are several gullies, probably caused by run-off and/or pedestrian traffic. The surface of the slope is overgrown with numerous saplings, tall grass and bramble bushes. Several concrete slabs about 10 feet long and 12 inches wide, reportedly remnants of the old gatehouse roof, have been placed on the slope. (See Photograph No. 4).

c. Appurtenances

The outlet-spillway is in generally good condition. The stone masonry training walls are in good condition with only minimal growth of vegetation through the stones. (See Photograph No. 5). The right wall is capped with about six

definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Validity

In general, the information obtained from the available drawings and personal interviews is consistent with observations made during the inspection and, therefore, considered reliable.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data and specific memoranda are not available for evaluation of the original construction of the dam. There is a drawing available which shows the survey data for the Pond, a section of the dam and outlet spillway, and a plan and profile of the outlet-spillway. Another drawing, available at the Water Division, shows the location and profiles of the pipeline which supplies the Pond from Suntaug Lake. The evaluations shown on the above drawing refer to the Peabody Water Department datum. There is no correlation available between the Peabody datum and the USGS datum. However, located on the upstream slope of Spring Pond Dam, near the left abutment there is a bench mark whose elevation is reportedly based on USGS datum. At the time of the inspection, an elevation of the top of the dam using this bench mark was determined by levelling. Comparing this elevation to the one shown for the top of dam on the drawing indicates the Peabody datum to be 3.77 feet above the USGS datum. All elevations referred to in this report are based on USGS datum.

There is no information available on subsurface conditions.

2.2 CONSTRUCTION RECORDS

There are no construction records available.

2.3 OPERATION RECORDS

Operation records and daily records of rainfall are recorded and available at the pumping station just downstream from the dam site. Records of pool elevations, which are taken weekly, are available at the Winona Treatment Plant, West Peabody, Mass.

2.4 EVALUATION OF DATA

a. Availability

Existing information was made available by Water Division, Public Service Department, Peabody, Mass.; Engineering Department, Essex County, Salem, Mass.; and Department of Environmental Quality Engineering, Division of Waterways, Boston, Mass.

b. Adequacy

The lack of in-depth engineering data did not allow for a

j. Regulating Outlets

The regulating outlet consists of a pipe and stone masonry structure, which in combination forms an outlet-spillway. The outlet pipe is 30 inches in diameter, about 50 feet long and leads to the stone masonry structure which forms a spillway. The spillway is fitted with flashboards which are manually adjusted for the full height of the structure. The flashboards are adjusted daily.

f. Reservoir Surface (acres)

Top of dam	70.6
Test flood pool	70.4
Flood-control pool	Not Applicable
Recreation pool (El 68.7)	69.4
Spillway crest	69.4

g. Dam

Type	Earthfill
Length, feet	225+
Height, feet	10+
Top width	Varies from 19 to 24 ft .
	20 feet average
Side Slopes - U/S	1V on 2.5H
D/S	1V on 2H
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel

Type	Not Applicable
Length	Not Applicable
Closure	Not Applicable
Access	Not Applicable
Regulating facilities	Not Applicable

i. Spillway

Type	Pipe
Length of weir	30 inch diameter
Crest elevation (w/flashboards)	68.7
(w/o flashboards)	59.73
Gates	None
U/S channel	None
D/S channel	None - Fountain Pond
	Immediately downstream from dam

flows through Peabody and into the North River and then Beverly Harbor. The drainage area of Spring Pond is 280 acres (0.44 square miles) of which about 22 percent is occupied by the Pond. Most of the land area is adjacent to the east shore and only a small portion of the area is drained by a short tributary with a defined channel.

b. Discharges at Damsite

Discharges at the damsite are through a cast iron pipe and stone masonry structure, which combined forms an outlet-spillway. The outlet pipe is 30 inches in diameter, about 50 feet long and leads to the stone masonry structure which forms a spillway about 3 feet long and with a freeboard of 10.5 feet, without flashboards. The computed maximum discharge capacity, with the Pond level at the top of the dam, El 70.23, is 80.2 cfs. There is no record of the maximum flood at the damsite. It is reported that the dam has never been overtopped. The maximum recorded pond elevation within the past 15 years was El 68.74 and occurred on May 12, 1977. It was attained by a controlled opening of the aqueduct leading from Suntaug Lake and not a result of a heavy storm flow.

c. Elevation (ft. above MSL)

Top of dam	70.23
Maximum pool-design surcharge	Unknown
Maximum pool-test flood	69.98
Full flood control pool	Not Applicable
Recreation pool	68.7
Spillway crest (gated)	Not Applicable
Upstream portal invert diversion tunnel	Not Applicable
Downstream portal invert diversion tunnel	Not Applicable
Streambed at centerline of dam	59.7 ±
Maximum tailwater	Unknown

d. Reservoir

Length of maximum pool, feet	3300 +
Length of recreation pool, feet	3300
Length of flood control pool	Not Applicable

e. Storage (acre-feet)

Recreation pool (El 68.7)	418
Flood control pool	Not Applicable
Design surcharge	Unknown
Test flood surcharge	90
Top of dam	525

appurtenances.

f. Normal Operating Procedures

Normal water releases from Spring Pond into Fountain Pond are controlled by the adjustment of flashboards. Water from Fountain Pond flows into a City-owned pumping station located at the downstream toe of Fountain Pond Dam. Normal water supply demand averages about 5 mgd. The level of Spring Pond is generally maintained by control of inflow through an aqueduct from Suntaug Lake.

g. Size Classification

The dam is less than 40 feet high and has a storage capacity of less than 1000 acre-feet, therefore, is classified as a small dam.

h. Hazard Classification

The dam is in a significant hazard potential category because downstream there is a pumping station, a cemetery, a small bridge and on higher ground adjacent to Fountain Pond, several homes which may be damaged in the event of a dam failure.

For details on the selection of the hazard potential category see Section 5.1d.

i. Operator

The person responsible for the day-to-day operation of the dam is:

Mr. Alan Taubert, Director
Water Division
Public Service Department
Berry Street
Peabody, Mass.

Telephone No.: (Office) 617-531-5135
(Home) 617-535-3652

1.3 PERTINENT DATA

a. Drainage Area

Spring Pond is located on Tapley Brook and its watershed is adjacent to the watersheds of Frog Pond to the south, and Browns Pond to the east. Spring Pond discharges to the north into Fountain Pond and subsequently into Sidney's Pond. Further downstream Tapley Brook joins Goldthwait Brook which

unpaved roadway is relatively straight and varies in width from about 19 to 24 feet with an average of about 20 feet. The upstream slope is about 1V on 2.5H and protected by cemented riprap. The grass covered downstream slope is about 1V on 2H.

A cast iron pipe and stone masonry structure combine to form an outlet-spillway which is located about 25 feet from the left end of the embankment. The outlet pipe, about 50 feet long, 30 inches in diameter, passes under the base of the dam and leads to the stone masonry structure which forms the spillway. Discharges over the spillway are controlled by a weir consisting of 3 feet long flashboards which can be manually adjusted for the full height of the structure. The freeboard without flashboards is 10.5 feet. Flanking the spillway are two 3.5 feet wide, 16 feet long stone masonry training walls. A gatehouse, which has been destroyed and is no longer in existence, was located on the crest above the spillway. Presently, the spillway is covered by steel plates located on the old gatehouse floor. Access to the flashboards is provided by a steel door flush with the plates; the door is bolted to prevent unauthorized entry.

The flow from the spillway is into Fountain Pond (also known as Lower Spring Pond) then into Tapley Brook, North River and Beverly Harbor.

b. Location

The dam is located in the southern portion of the City of Peabody, just north of the Peabody-Lynn borderline, east of the intersection of Lynn Street and Sunset Drive.

c. Ownership

Spring Pond Dam is owned by the City of Peabody. The day-to-day operation and maintenance is managed by the Water Division, Public Service Department, Peabody, Massachusetts.

d. Purpose of Dam

The impoundment provided by the dam is a water storage reservoir from which is drawn about 80% of the City of Peabody's water supply.

e. Design and Construction History

Original design and construction records are not available. The exact year the dam was built is unknown but reportedly the dam was constructed about 1900. Past inspection reports, summaries of which are in the Appendix, indicate that over the years several changes and repairs have been made to the

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NORTH RIVER BASIN
INVENTORY NO. MA 00193
SPRING POND DAM
CITY OF PEABODY
ESSEX COUNTY, COMMONWEALTH OF MASSACHUSETTS

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of the dams within the New England Region. Tippetts-Abbott-McCarthy-Stratton has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Tippetts-Abbott-McCarthy-Stratton under a letter of May 3, 1978, from Mr. Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0298 has been assigned by the Corps of Engineers for this work.

b. Purpose

- (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
- (2) Encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.
- (3) To update, verify and complete the National Inventory of Dams.

1.2 DESCRIPTION OF THE PROJECT

a. Description of Dam and Appurtenances

Spring Pond Dam is an earthfull embankment about 225 feet long with a maximum height of about 10 feet. The crest of the dam, which serves as an

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Visual observations did not indicate any serious structural problems with the embankment, and outlet-spillway. The deficiencies described in Section 3 require attention and measures to improve these deficiencies are given in Section 7.

b. Design and Construction Data

No design computations or other data pertaining to the structural stability of dam have been located.

On the basis of the past performance experience, the visual inspection, as well as engineering judgment, the dam at present appears to be structurally adequate.

c. Operating Records

There are no records or reports of any operational problems which would affect the stability of the dam.

d. Post-Construction Changes

It is reported that the dam was built in about 1900. Many minor construction changes have been made over the years. These changes are described in the summarized Essex County inspection reports given in the Appendix.

e. Seismic Stability

The dam is located in Seismic Zone 3. There are no seismic records available at the damsite. Since the dam is in relatively good condition, is small in size and retains a low head of water, a seismic analysis is considered not warranted for this Phase I evaluation.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition

Phase I investigation of Spring Pond Dam does not indicate conditions which would constitute an immediate hazard to human life or property. Based on engineering judgment and the performance of the earth embankment and outlet works, the project appears to be in good condition. The project, however, does have inadequacies and deficiencies which, if not remedied, have the potential for developing into hazardous conditions.

Because there are no data on Probable Maximum Floods (PMF) for such a small drainage area, it was necessary to synthesize a test flood hydrograph for the contributing area.

Since the dam is classified as small in size, with a significant hazard potential, the test flood in accordance with Corps of Engineers' guidelines is between the 100-year flood and one half the Probable Maximum Flood (1/2 PMF). The 100-year precipitation for Peabody, Massachusetts, is 4.75 inches in 6-hours. Assuming losses to be negligible, the volume of the 100-year flood would be 110.8 acre feet, corresponding to less than a 2 foot rise of lake level, if no outflow is assumed. The Test Flood hydrograph constructed to represent instantaneous conversion to runoff has a peak of 584 cfs (1335 csm). The Maximum Probable Precipitation (PMP) for the area is 23.4 inches for a 6-hour rainfall over a 10-square mile area. Applying required adjustments, the resulting runoff equivalent to the PMF is 17.78 inches over the entire watershed. The volume of the 1/2 PMF would be 207.4 acre-feet. The flood hydrograph for the 1/2 PMF constructed to represent instantaneous conversion of rainfall to runoff has a peak of 1093 cfs (2498 csm).

The adequacy of the spillway was tested by routing the selected Test Flood (100 year) through the reservoir using a computer routing technique. The water surface was assumed to be at the normal pool level (El 68.7) at the start of the storm. The resulting peak outflow from the 100-year flood was 78 cfs corresponding to El 69.98 or 0.25 feet below the crest of the dam.

Since the dam is not expected to be overtopped with an inflow equal to the 100-year flood, it is considered that the spillway is adequate from a hydraulic and hydrologic standpoint.

b. Adequacy of Information

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Urgency

The remedial measures described in a subsequent paragraph should be undertaken by the owner within 24 months after receipt of this Phase I Inspection Report.

d. Necessity for Additional Investigations

Additional investigations to assess the adequacy of the dam and appurtenant structures do not appear necessary.

7.2 RECOMMENDATIONS

None.

7.3 REMEDIAL MEASURES

a. Alternatives

None.

b. Operating and Maintenance Procedures

It is recommended that the following measures be undertaken by the owner within 24 months after receipt of this Phase I Inspection Report.

1. Establish a formal program of operation and maintenance and initiate biennial inspections of the dam.
2. Provide 'round-the-clock' surveillance during periods of unusually heavy precipitation.
3. Develop, with local officials, a formal system for warning downstream residents in case of emergency.
4. Keep all vegetation in a close cut condition.

5. Remove all brush, shrubs and young saplings from both slopes and the crest.
6. Refill areas of erosion and gullies on the downstream slope and crest.
7. Replace stones missing on upstream riprap slope protection.
8. Traffic on the crest should be eliminated. If this is not practical, consideration should be given to paving the crest.
9. Consideration should be given to relocating the high voltage transmission tower off the dam crest.

VISUAL INSPECTION CHECKLIST

APPENDIX A

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT SPRING POND DAM

DATE 11-16-78

TIME 10.00 AM

WEATHER Sunny 50°-60°F

W.S. ELEV. 66.2 U.S.

PARTY:

- | | |
|------------------------------|-----------|
| 1. <u>Harvey S. Feldman</u> | 6. _____ |
| 2. <u>Jyotindra H. Patel</u> | 7. _____ |
| 3. _____ | 8. _____ |
| 4. _____ | 9. _____ |
| 5. _____ | 10. _____ |

- | PROJECT FEATURE | INSPECTED BY | REMARKS |
|--|--------------|---------|
| 1. <u>All project features are inspected by above party members.</u> | | |
| 2. _____ | | |
| 3. _____ | | |
| 4. _____ | | |
| 5. _____ | | |
| 6. _____ | | |
| 7. _____ | | |
| 8. _____ | | |
| 9. _____ | | |
| 10. _____ | | |

PERIODIC INSPECTION CHECK LIST

PROJECT SPRING POND DAM DATE 11-16-78
 PROJECT FEATURE _____ NAME _____
 DISCIPLINE _____ NAME _____

DAM EMBANKMENT

Crest Elevation (MSL) 70.23

Current Pool Elevation (MSL) 66.2

Maximum Impoundment to Date _____

Surface Cracks None observed

Pavement Condition Generally good

Movement or Settlement of Crest None observed

Lateral Movement None observed

Vertical Alignment Good except some depressions and ruts which have been created by traffic, especially trail bikes.

Horizontal Alignment Good

Condition at Abutment and at Concrete Structures Generally good at abutments.

Indications of Movement of Structural Items on Slopes None

Trespassing on Slopes Only at downstream slope

Sloughing or Erosion of Slopes or Abutments Several gullies on downstream slope

Rock Slope Protection - Riprap Failures Upstream Slope - uncemented portion of riprap shows some displaced and missing stones. (See Misc. Comments)

Unusual Movement or Cracking at or near Toes None observed

Unusual Embankment or Downstream Seepage None observed

Piping or Bolls None observed

Foundation Drainage Features None

Toe Drains None

Instrumentation System There is a bench mark established by owner, at upstream slope near left abutment. Elevation of this is 68.70 MSL.

Miscellaneous. At crest there are several high voltage transmission towers and telephone poles.

Several concrete tower footings were observed on the crest.

There is vegetation growing up through the suprap consisting of saplings, tall weeds and grass.

Two 8 inch pipes are located on either side of the spillway and about one foot below and through the dam crest. These pipes are plugged.

There are several gullies, probably caused by run-off and/or pedestrian traffic on downstream slope.

PERIODIC INSPECTION CHECK LIST

PROJECT SPRING POND DAM

DATE 11-16-78

PROJECT FEATURE _____

NAME _____

DISCIPLINE _____

NAME _____

OUTLET WORKS - INTAKE CHANNEL AND
INTAKE STRUCTURE

None.

a. Approach Channel

Slope Conditions _____

Bottom Conditions _____

Rock Slides or Falls _____

Log Boom _____

Debris _____

Condition of Concrete Lining _____

Drains or Weep Holes _____

b. Intake Structure

Condition of Concrete _____

Stop Logs and Slots _____

PERIODIC INSPECTION CHECK LIST

PROJECT SPRING POND DAM DATE 11-16-78

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

OUTLET WORKS - CONTROL TOWER

a. Concrete and Structural None

*Gate house demolished. Floor
of the gate house visible at the crest*

General Condition _____

Condition of Joints _____

Spalling _____

Visible Reinforcing _____

Rusting or Staining of Concrete _____

Any Seepage or Efflorescence _____

Joint Alignment _____

Unusual Seepage or Leaks in Gate Chamber _____

Cracks _____

Rusting or Corrosion of Steel _____

b. Mechanical and Electrical

Air Vents _____

Float Wells _____

Crane Hoist _____

Elevator _____

Hydraulic System _____

Service Gates _____

Emergency Gates _____

Lightning Protection System _____

Emergency Power System _____

Wiring and Lighting System _____

PERIODIC INSPECTION CHECK LIST

PROJECT SPRING POND DAM DATE 11-16-78

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

OUTLET WORKS - OUTLET STRUCTURE AND

OUTLET CHANNEL *No outlet channel ; downstream
of Dam is Fountain Pond.*

General Condition of Concrete _____

Rust or Staining _____

Spalling _____

Erosion or Cavitation _____

Visible Reinforcing _____

Any Seepage or Efflorescence _____

Condition at Joints _____

Drain Holes _____

Channel _____

Loose Rock or Trees Overhanging Channel _____

Condition of Discharge Channel _____

PERIODIC INSPECTION CHECK LIST

PROJECT SPRING POND DAM DATE 11-16-78
 PROJECT FEATURE _____ NAME _____
 DISCIPLINE _____ NAME _____

OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS

*Spillway - outlet structure
 consist of stone masonry and an
 30 inch diameter outlet pipe*

1. Approach Channel *None*
 General Condition _____
 Loose Rock Overhanging Channel _____
 Trees Overhanging Channel _____
 Floor of Approach Channel _____

2. Weir and Training Walls *No weir and entire width with Flashboards;
 training walls are stone masonry*
 General Condition of ~~Concrete~~ *stone* Good
 Rust or Staining None
 Spalling None
 Any Visible Reinforcing None
 Any Seepage or Efflorescence None
 Drain Holes None

3. Discharge Channel *which leads to Fountain Pond which
 clear and clean*
 General Condition generall good
 Loose Rock Overhanging Channel None
 Trees Overhanging Channel None

Floor of Channel Condition unable to determine because
of flow in the channel

Other Obstructions None

Miscellaneous At time of inspection there were about
40 inches of flashboard in place. There was flow
above flashboard.

The outlet pipe condition could not
be determined because it was underwater.

Report to Co. Comm 1933

should be adopted which would make it impossible to raise and hold the water level so high that the freeboard would be less than about three to four feet or if extra storage capacity is considered essential, the top of the dam should be raised.

Fountain Pond Dam is probably sufficient under any conditions to be reasonably expected if the water level be kept a few feet below the top of the dam and if the gate be opened promptly when necessary and all stop plank removed. It would be a comparatively simple matter to pave or riprap the lower face of this dam so that it would safely withstand an overflow along its whole length and this would be a far more adequate protection as there are now too many chances that some one will fail to take proper measures at the proper time to avert trouble.

The Sidney's Pond Dam below Fountain Pond is only partially in use and through an agreement with the proprietors of the cemetery above, only four feet of water is maintained in it. It has apparently been many years since the water has been raised much higher than this and nothing is known as to the tightness of this dam under such conditions of high water. Assuming that it would safely withstand filling to the top of the dam, it might provide through the present spillway a sufficient outlet under all circumstances but there is considerable uncertainty, and a larger outlet, at least above the normal level of the water, might well be provided.

The Danvers Bleachery Dam just below the junction of the two streams was built within a comparatively few years and is apparently well built and in good condition but the capacity of the spillway as built is less than one half of the flow which I believe might reasonably be expected under extreme conditions. It could be improved to a considerable extent by removing the wall at the lower end of the outlet chamber which has an opening in it of rather restricted area through which the water must flow, but even then in order to safely discharge the required amount through the spillway it would be necessary to raise the top of the dam at least three or four feet or to lengthen the spillway.

The other dams on these streams I believe, are unimportant from the standpoint of safety and those in use are generally in good condition and reasonably safe for the condition.

These conclusions are not in most respects materially different from what has been stated in previous reports but they are based on a much more thorough investigation than any which had been made up to this time, and I wish again to emphasize the fact which has been stated in previous reports that there are other conditions which might result in damage along this stream, which do not depend upon the safety of these dams, or the sufficiency of their spillways, and the flooding of the stream valley below would not be prevented by the changes here recommended.

I believe that even the spillway of the Danvers Bleachery dam will now probably discharge as much water as can flow through the stream below it, which passes through nine culverts before it reaches

Dec. 11, 1933

PEABODY

At the time of my report to you in 1932 upon the condition of the dams in the southeast part of the County including those in the city of Peabody, the dams on Goldthwaite Brook and Tapley Brook in that city had been inspected and were included in the table accompanying the report, but surveys were then being made to secure data for further study and it was stated that a separate report on these structures would be made as soon as possible.

These surveys were completed early in the present year and taking advantage of such opportunities as have presented themselves, we have made observations of the effect of various storms on the level of the ponds and the run-off from these watersheds to determine whether conditions here are materially different from what would ordinarily be expected. There have been several storms with heavy rainfall during the year but nothing more than what is to be reasonably expected every few years.

Under such conditions as we have observed the flow in the main stream is low for the area of watershed tributary to it, due to the storage capacity of the ponds and swamps on the watersheds above.

Two of the ponds on the watershed of Tapley's Brook which is the south branch of the main stream are used as a source of water supply, and since the city of Peabody is faced with a shortage of water it follows that these ponds are usually drawn down well below their highwater levels so that at such times they will retain the runoff from a fairly heavy storm without overflowing, and on the Goldthwaite Brook watershed, there is a large area at the upper end around Cedar Pond which is flat and swampy so that the whole area ordinarily contributes very slowly to the flow of the stream below.

It is evident, however, that this storage effect prevails only in the storms of not unusual severity and in the event of an extremely heavy rainfall such as occurs on an average of not more than once in fifty or one hundred years at the same locality, these beneficial effects of storage would be lost when all ponds and swamps were filled. Without doubt the main stream would then have a maximum discharge far in excess of what we have observed, as although the rainfall might be only three or four times as great as what we have observed, the flow would be many more times as great because with all storage capacity absorbed the entire watershed would be contributing its runoff.

We have twice observed that Spring Pond was full substantially to the top of the dam and apparently was purposely held at that level, so that it is plain that the fact of heavy draft on these ponds for a water supply cannot be relied upon as a protection.

In order to put all these dams in condition such that no failure would reasonably be expected even in the event of the storm of rare frequency above assumed, some method of control of Spring Pond

this slight damage is to be avoided, the outlet at Lake Street should be improved and possibly the street should be raised and at the dam owned by J. F. Cobb the construction at the ends of the dam could well be improved.

W. F. Cobb

0701
1000

damage due to anything which might be classed as a failure of the dam. The abandoned dam owned by the Danvers Bleachery Company on Goldthwait Brook further down the brook does not now hold back any water. The dam belonging to the Danvers Bleachery Company on Goldthwait Brook still further down the stream seems to be in good condition and has fairly ample provisions for storm water if stop plank were removed promptly, and there is flat open country quite extensive in area below the dam. Below the last dam above mentioned is a small affair east of Allen's Lane owned by the Essex Gelatin Company, which could not do any damage through failure, and still further down is another structure, equally unimportant.

On the whole, I do not feel that any of these dams on Goldthwait Brook and Tapley Brook require any immediate action. The only possibility which occurs to me is, that in a very excessively heavy storm, starting at the upper end of each brook, partial failures each adding its cumulative effect might produce a condition in the lower portions of the stream as it approaches the main street in Peabody which would cause damage there, and I have not enough data at hand to feel sure that even in this event there is likelihood that such damage would be due even in major part to the possible failure of the structures rather than to the capacity or lack of capacity of the brook in its lower stretches. I gave no notice to any of the agents of the industrial plants above mentioned before inspecting the dams. The dam on Lake Street at the end of Devils Dishfull Pond near the B. & M.R.R. is in rather uncertain condition and it is easily believable that it may overflow and possibly cut away a channel which would drain the pond down to some extent, but there seems to be no opportunity for serious damage below at least until the small ponds at Phelps Mill are reached, and here the upper dam is hardly more than a causeway through the pond while the lower dam, although not very substantial, holds the water at a level so little above the road, a few hundred feet below, that it is hard to believe that there would be any serious damage there or in the extensive low swampy land beyond the road. However, if even

0125-50

DAMS IN PEABODY - INSPECTED NOVEMBER 22, 1928.

With Mr. P. H. Koshier, City Engineer of Peabody, visited Browns Pond Dam, Spring Pond Dam, and Fountain Pond Dam and found conditions substantially as stated in Mr. Barker's report. The structure at Brown's Pond should hardly be classed as a dam since the pond is so little above the surrounding country and except for such water as could escape down the ditch, there could be nothing but a broad sheet of shallow water flowing from the pond in any case. At Spring Pond, with all outlets open, the run-off, even from excessive storms, would probably be taken care of and under present conditions the water would overflow the land west of the dam in a broad shallow stream through flat country before it reached the top of the dam. The dam itself would stand some overtopping and there seems to be no reason to expect a sudden failure even under extreme conditions which could occur. The overflow would find its way to the pond immediately below, Fountain Pond, and the dam at the north end of that pond has an apparently substantial masonry wall on the down stream face which should, in an emergency, stand up even if overtopped for its full length to some considerable depth. The land in the cemetery just east of the dam is slightly lower than the top of the dam and there is some possibility that the water might find its way around here and do some damage to the cemetery though apparently not very serious. With all flash boards removed from the outlet through this dam, and with the gate open, provisions for discharge of flood waters are fairly liberal. The conditions at both of these ponds last mentioned would be considerably improved by providing more adequate spillways, but the likelihood of any serious failure seems remote enough in view of the flat open country for some distance below the lower dam, so that it is doubtful whether more ample provisions should be insisted upon.

On the same day as above, I looked at other dams in Peabody as follows: The dam belonging to the Tanners Products Company on Goldthwait Brook north of Lynnfield Street, where it would seem that, although there are possibilities of flooding the buildings from overflow, there is no possibility of



JAMES R. CARLIN, P.E.
COUNTY ENGINEER

MAURICE T. DENCH, P.E.
F. RICHARD GELOTTI
ASST. ENGINEERS

COUNTY OF ESSEX
OFFICE OF COUNTY ENGINEER
COURT HOUSE, SALEM, MASS. 01970

744-1240 Ext. 14

RECEIVED

September 18, 1978

SEP 21 1978

SOILS SECTION

Jyoti Patel
T.A.M.S.
345 Park Ave.
New York, New York 10022

Dear Sir:

We have quite a bit of information on the Spring Pond Dam and Browns Pond Dam in Peabody, including periodic report sheets.

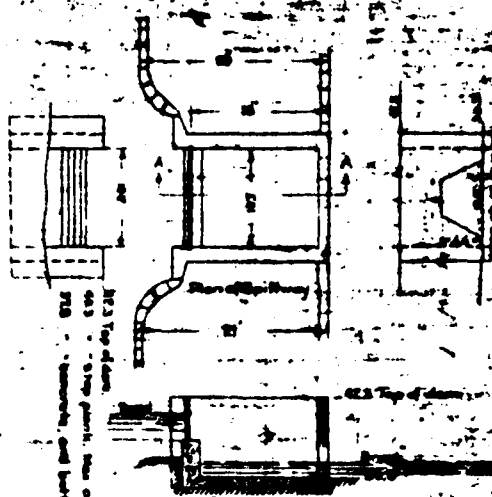
I suggest you come to the office and look over this information if you think any of it would be of any value to you.

Very truly yours,

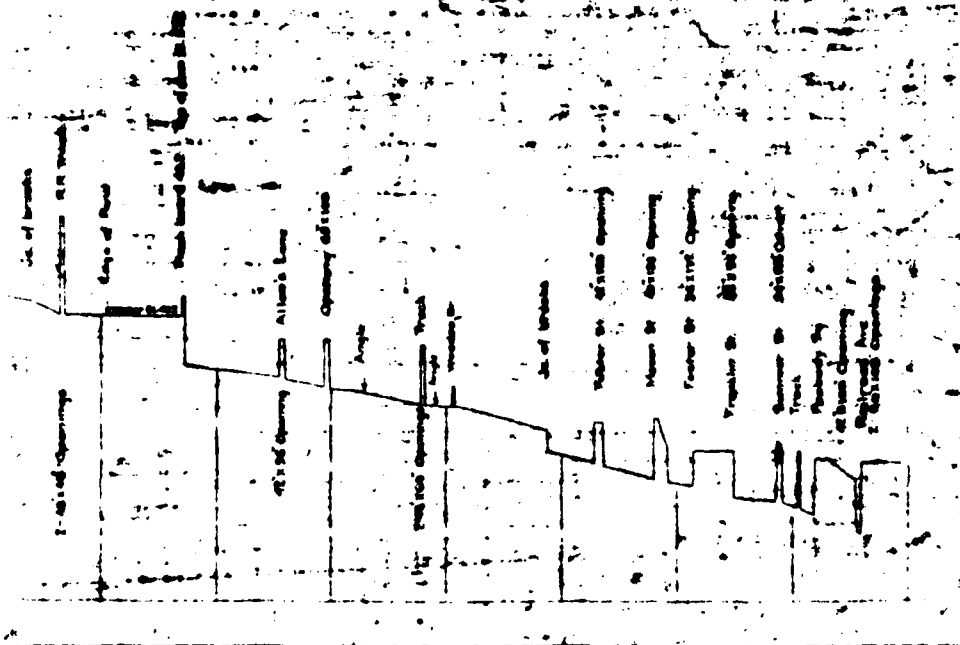
James R. Carlin
JAMES R. CARLIN
County Engineer

JC/fn

DAM AT SIDNEY'S POND
Boats 1-10

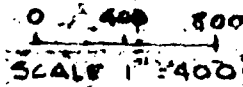


DANVERS BLEACHERY DAM
Scale 1" = 10'

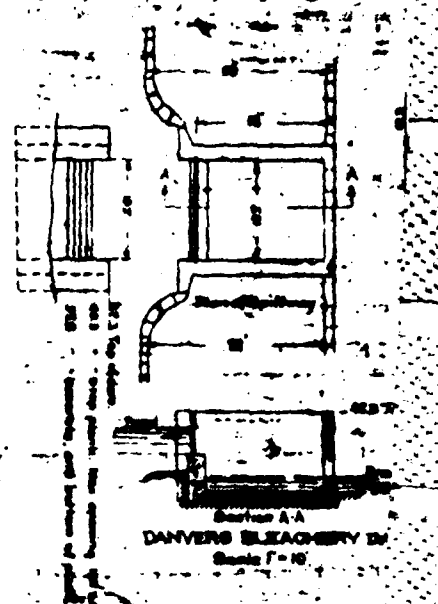
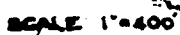


1241

**PEARSON
SALEM**

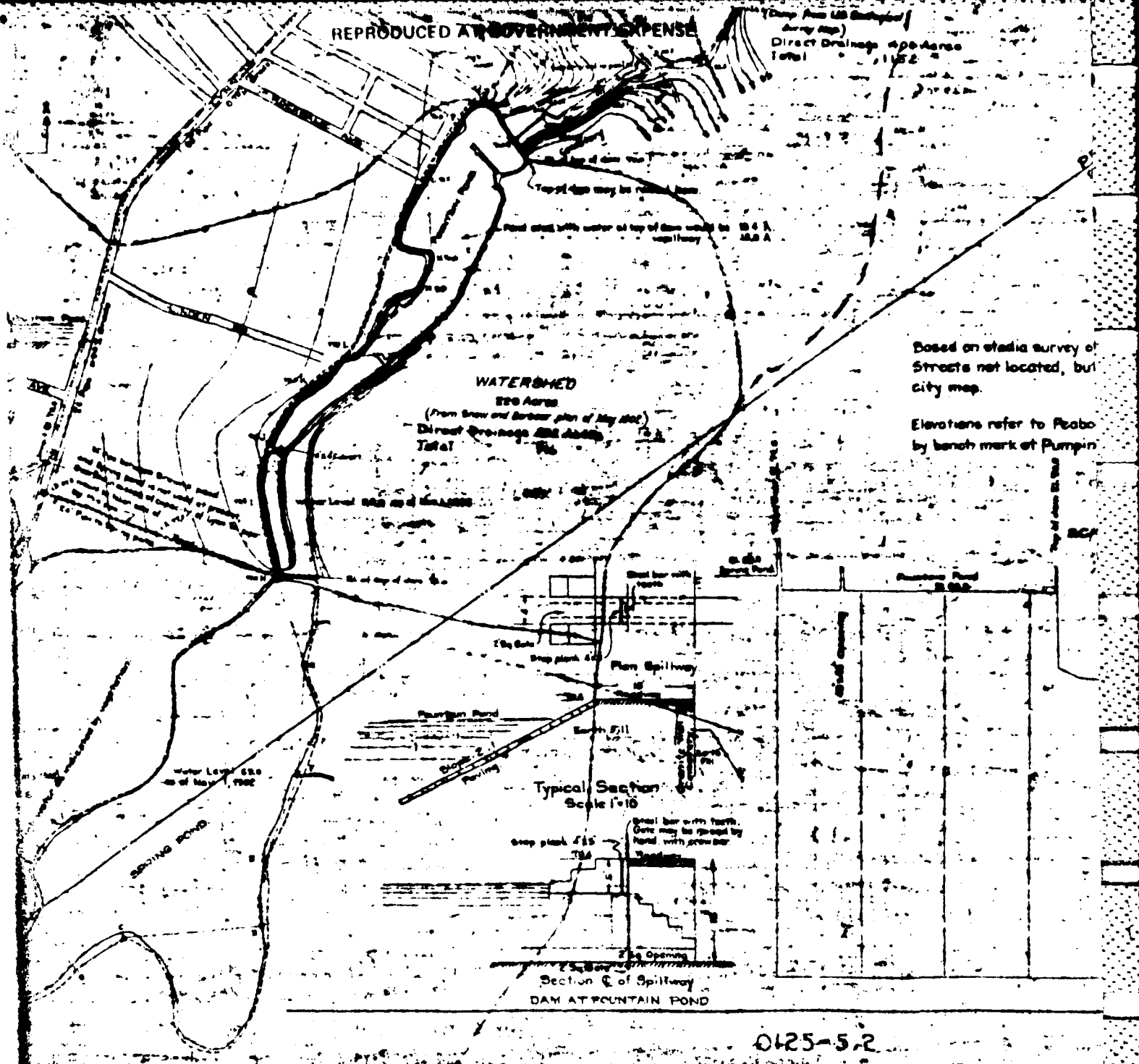


Elevations refer to Peabody Water base as indicated by bench mark at Pumping Station. (El of 89-44.94)

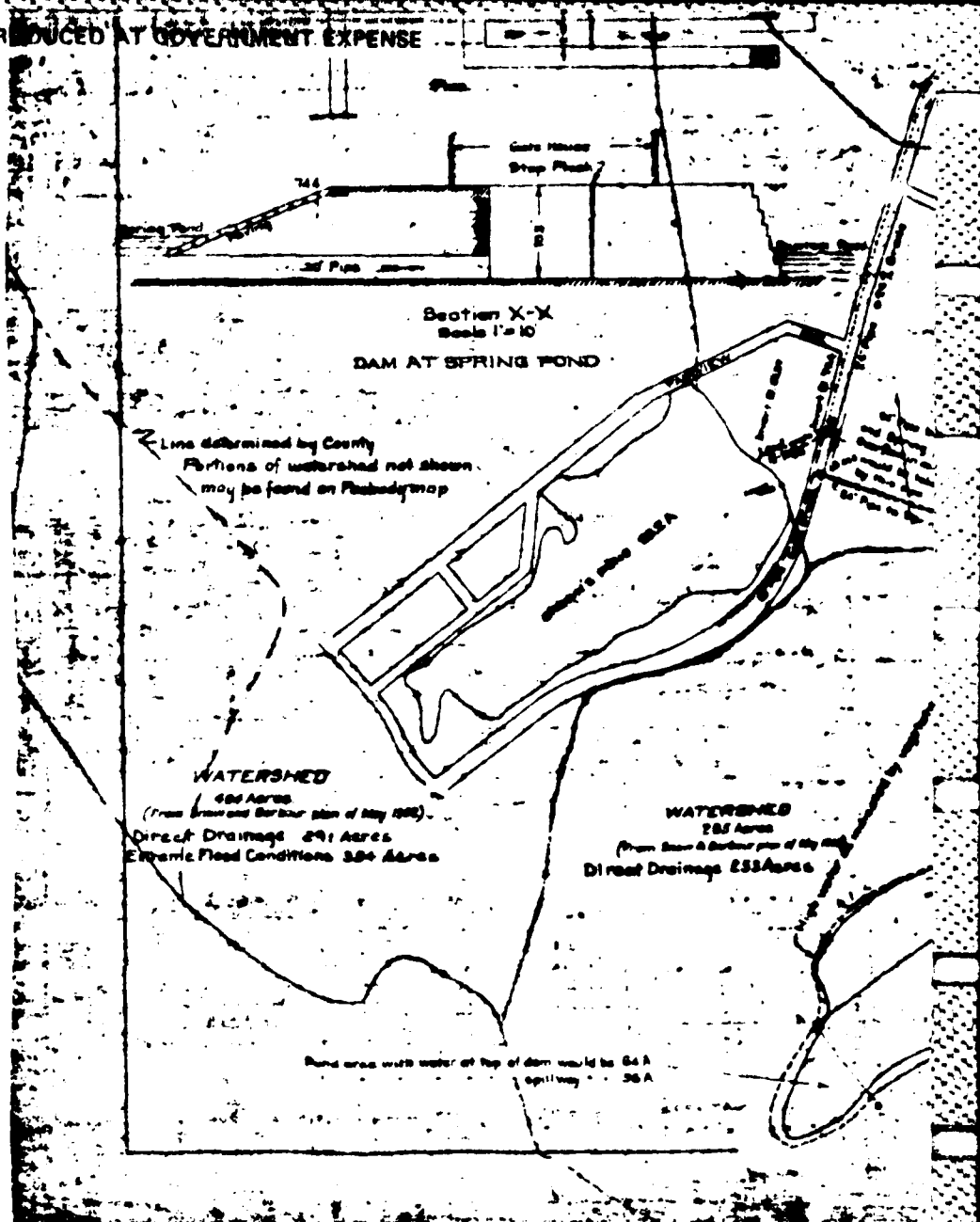


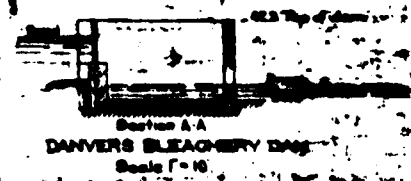
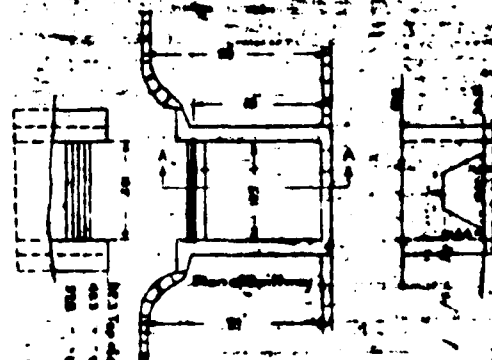
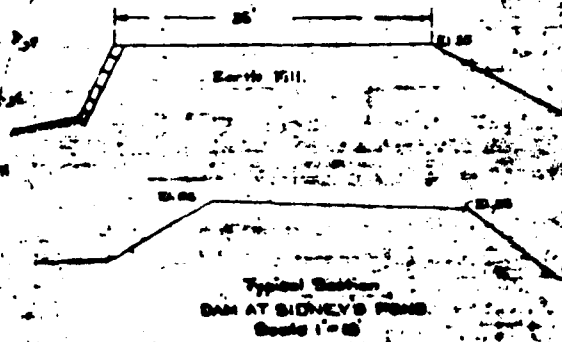
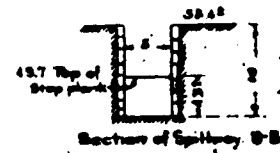
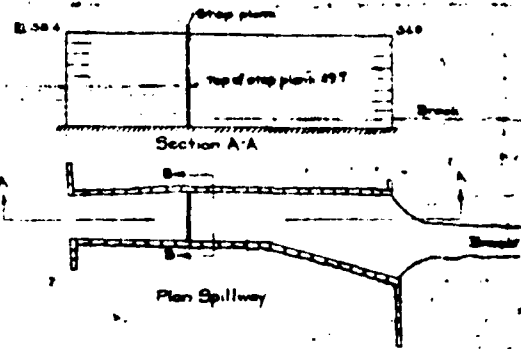
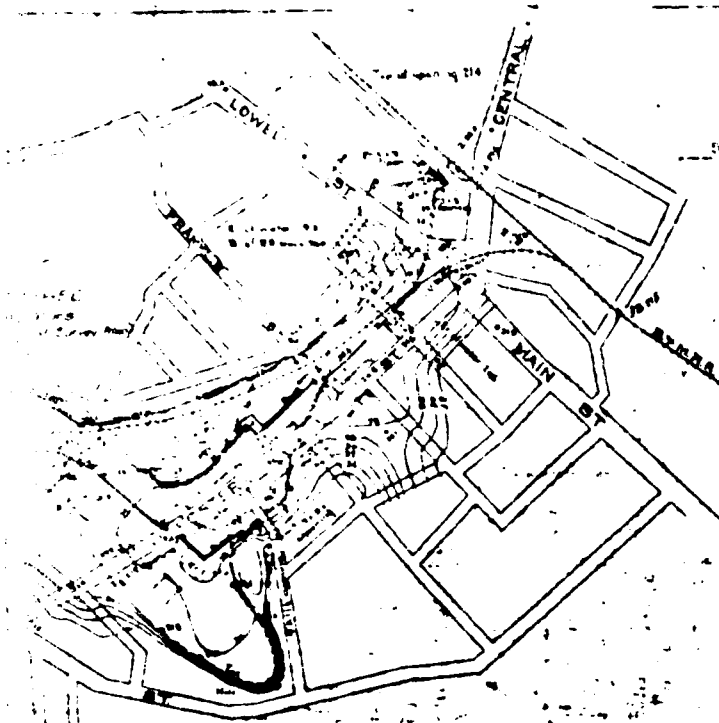
Scalen [Mar 1 - 200
 PROFILE ALONG THREAD OF BROOK

Direct Drainage 400 Acres
Total 1152



0425-52





water courses etc.
from Reservoir

base as indicated
(Elev. 44.0)

Direct Drainage 221 Acres
Total 8748
Extreme Flood Condition 8573

Pond area with water at top of dam would be 47 acres
- capacity - 79 acres.

Water Level 408
May 6 1902

WATERSHED
1.03 Sq. Miles
(Comp. from US Geological
Survey Map)

EMERSON PARK
WATERSHED
0.5 Sq. Miles
(Comp. from US Geological
Survey Map)

WATERSHED
0.5 Sq. Miles
(Comp. from US Geological
Survey Map)
Direct Drainage 406 Acres
Total 1132

WATERSHED
220 Acres
(From Snow and Gardner plan of May 1902)
Direct Drainage 221 Acres
Total 76

Based on stadia survey of principal water streets not located, but compiled from city map.

Elevations refer to Peabody Water base as by bench mark at Pumping Station. (El of 1

SCALE

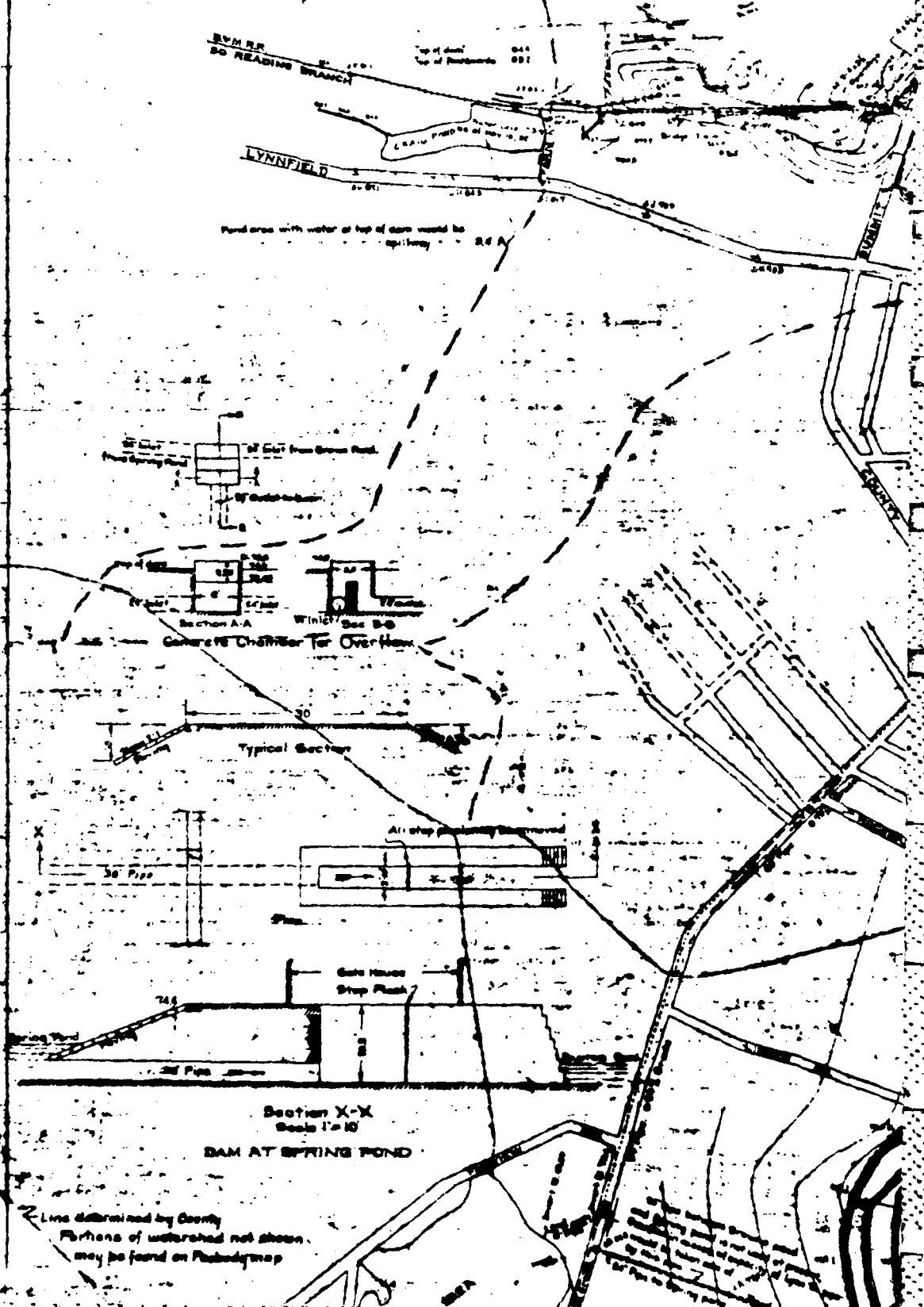
SCALE 1"=400'

22

Watershed around Cedar Pond Area
on Peabody City Map files with computations

Direct Drainage 1475 Acres
Extreme Flood Condition 1537

Direct
Drainage
Extreme



Line determined by County
Portions of watershed not shown
may be found on Peabody map

DRAWINGS AND INSPECTION REPORTS

APPENDIX B

Report to Co. Comm.

Peabody Square, so that in case of the rare storm which we are considering, the whole vicinity of the stream where it flows through the city of Peabody would be badly flooded even if the dams remain intact and this area consists in part of manufacturing establishments and a considerable business section as well as residences.

Regardless of such a flood condition, however it cannot be assumed that a breaking of one or more dams at such a time would not cause some further loss or damage such as it contemplated by the law requiring inspection of dams.

15

Robert R. Evans

COUNTY OF ESSEX, MASSACHUSETTS
ENGINEERING DEPARTMENT

Inspection of Dams, Reservoirs, and Stand Pipes

O/25-5C

SUB NUMBER

D. 12 R S. P.

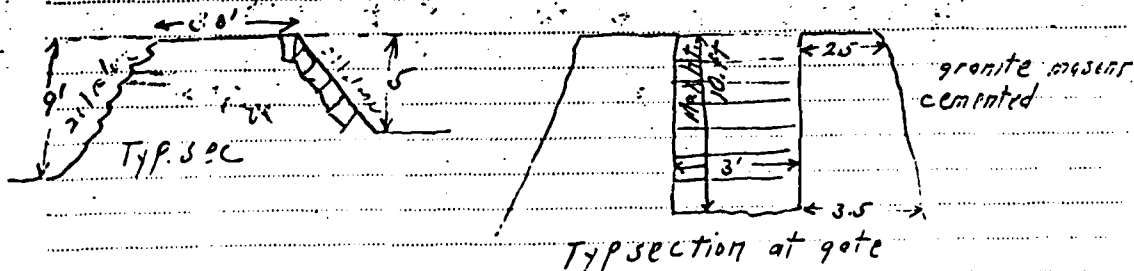
Neg. No. 137-

Inspector C. C. Barker Date April 9, 1913 *Classification 2
City or Town Peabody Location North end of Spring Pond
east of Lynn St.
Owner Peabody Water Works Use Water Supply
Include such details as cores, cut off walls, paving, sodding, class of masonry, kind of cement, (nat. or port.) etc.
Material and Type Earth, paved upper side with large & small flat stones

Elevations in feet: above (+) or below (-) full pond or reservoir level. (Cross out what does not apply.)
For Dam
Bed of stream below 20 Bottom of pond Bottom of spillway 0 Top of dam +6 Top of flash boards
For Res. or S. P.
Ground surface below Bottom of ice Level of over flow pipe Top of ice 0.5 ft. m.
For dam
Length in ft. 200 Top width in ft. 30 Pond area 63.6 Area of watershed 315 ac.
For Res. or S. P.
Inside dimensions Capacity 246,000 gal. covered open
Length of overflow or spillway 24 2 1/2 ft. Outlet pipes (size and nature) 12 7 mm pipe
Stand pipe, thick as at base 2 1/2 in. pipe 12 7 mm pipe
Foundation and details of construction filling S.P.

Constructed by and date
Recent repairs and date
Evidence of leakage Same below net, but I think there is no leakage
Condition Good S.P. when painted
Topography of country below Wet lands, wide channel of brook flat country
Nature, extent, proximity, etc. of buildings, roads or other property in danger if failure should occur Pumping Station and another dam at reservoir
Plans and data secured or available

Use separate sheet for sketches if necessary.
Notes, sketches, sections, etc.



No change 9 mo. Oct. 11, 1916 G. E. H.

*Classify as to probable damage in case of failure. 3 slight. 2 moderate. 1 serious.

Inspection of Dams, Reservoirs, and Stand Pipes

SUB NUMBER

D. 12 R. S. P

Neg. No. 437-9

City or Town Peabody Location North end of Spring Pond

east of Lynn St.
Owner Peabody Water Works Use Water Supply

Material and Type *Earth, paved upper side with large & small flat str.*

Elevations in feet: above (+) or below (-) full pond or reservoir level. (Cross out what does not apply.)

(Bed of stream below ~~17.0~~ Bottom of pond..... Bottom of spillway..... 0 Top of dam + 6 Top of flash boards.....

For Res. or S. P. _____
Ground surface below _____ Bottom of res. _____ Level of over flow pipe _____ Top of res. _____ 0 -

For dam
Length in ft. 200. Top width in ft. 30 Pond area 63.6 Area of watershed 315 acres

For Res. or S. P. *Y* Capacity *246,000 gal* covered *no*

Length of overflow or spillway 27 acorn pipe Outlet pipes (size and nature) 2" + 2" = Condens

Length of Overhaul of Spindles *12.1 mm* *pin*

Foundation and details of construction

Foundation and details of construction

Contract bond for

Constructed by and date 1984

Recent repairs and date: Paint below mast but all the bottom is no longer

Evidence of leakage

Condition Wet

Remarks Wet sand. No channels or beds visible.

Topography of country below: *rolling, some low hills, some grassy*

Nature, extent, proximity, etc. of buildings, roads or other property in danger if failure should occur.....

Sharon Ann and I have been in research

Plans and data secured or available

Use separate sheet for sketches if necessary.
 Notes, sketches, sections, etc.

Notes, sketches, receipts, etc.

granite masonry

centred

TYP. SEC

.....

T.P. section at gate

11/05/2017

Mochnow 909. Oct. 14 1916 R.E.W.

*Classify as to probable damage in case of failure. 3 slight, 2 moderate, 1 serious.

1. *Journal of the American Medical Association*, 2000; 283: 2689-2696.

Q 125-5-C

D/2

Dec. 20, 1923

Peabody, Spring Pond

July 26, 1928
Old wooden box
preserved by 30" x 24" pipe in 1927

Handing over to
the [illegible] by [illegible]

W. L. Brown's Post

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24th Oct 2017

7' deep 20' x 10' net by glenn

24' outlet to Spring Lake

~~Wooden Silver~~
11 1282

12x2

 2^{+6^+}
$$\leftarrow 12' \quad \rightarrow 12' \rightarrow$$

70nd

Eq. 17,

10-6

 2×2

Figure 2-2-4

Section "A-A"

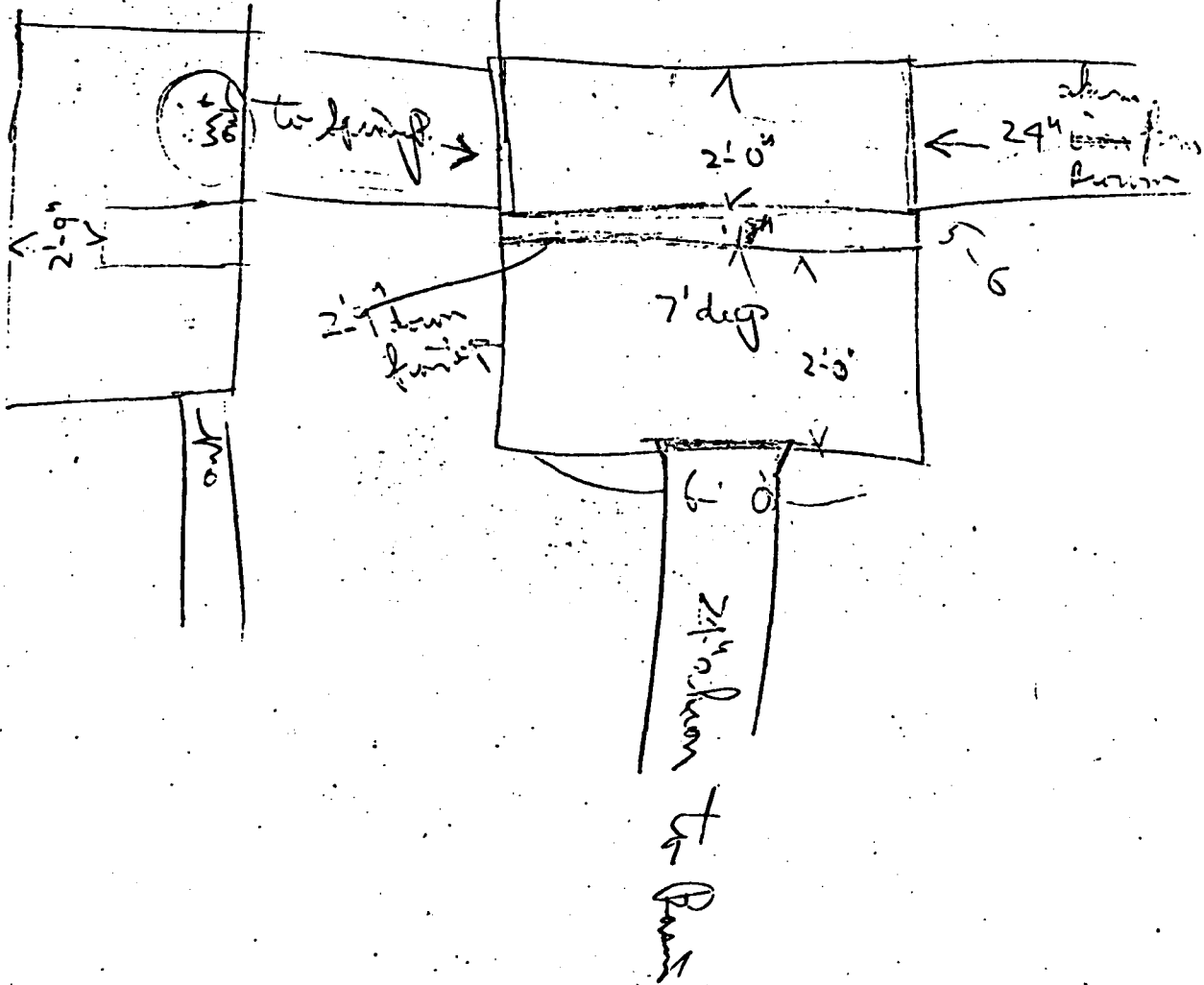
Perbody, Spring Pond
 0125-5-C.

Dec. 20, 1923 D12

~~to spring~~

Water can come
 within a 1 1/2 ft
~~to spring~~

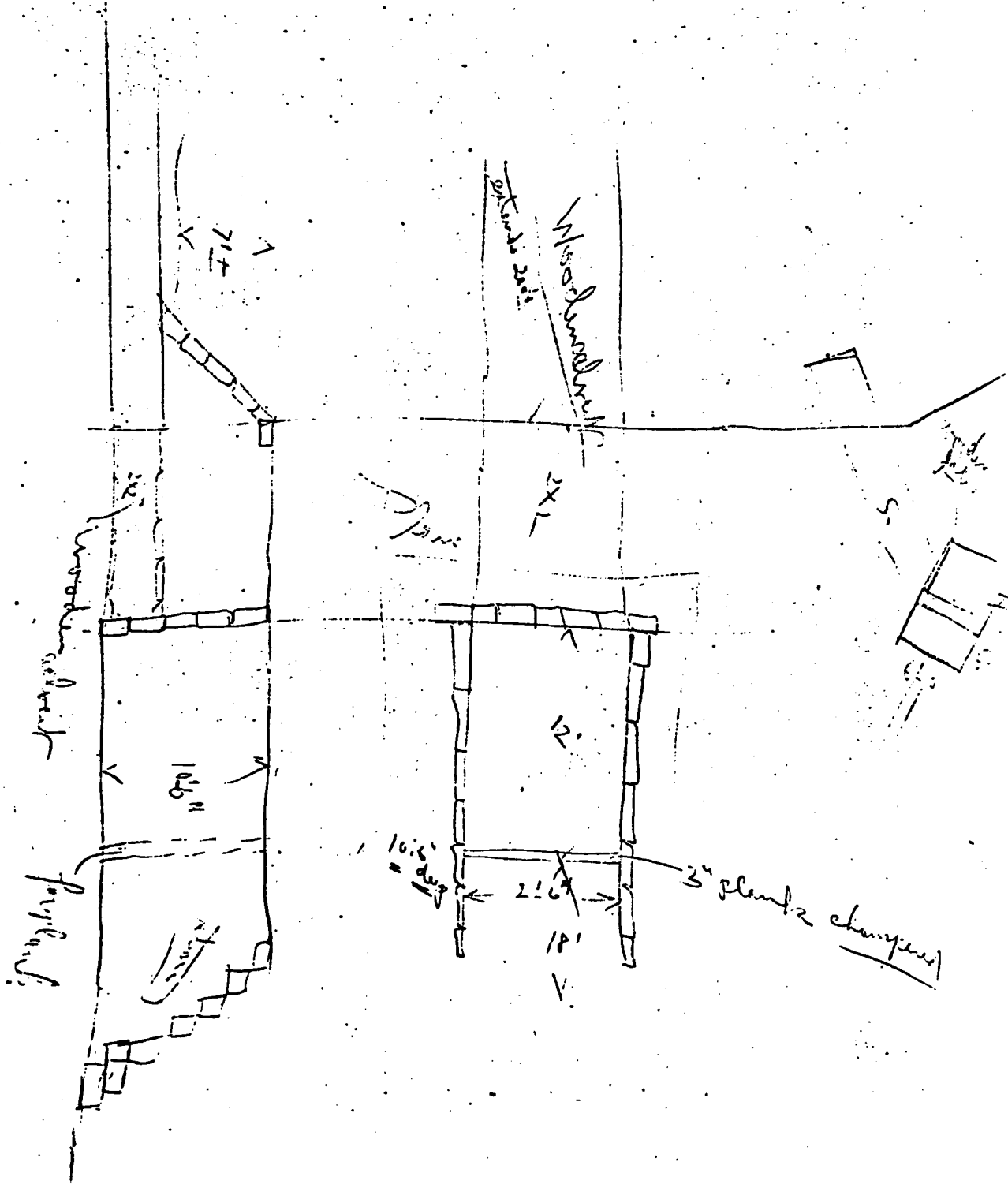
Wooden Gate to lift up or push out



Reabody Spring Pond

D12
Dec 20 1923

0125-5-C.



Peabody D. 12

1917, March 26. Watershed 0.5 sq. m. Max. Ht. 9.0 ft. Apparent condition, Fair.

1923, Nov. 26. R. R. Evans, Insp. Peabody Water Works. Spring Pond Dam at north end. Dam is in good condition except slope paving somewhat disturbed at end of 24 inch inlet pipe from Brown's pond. There is no overflow or sluice except that a wooden flume about 2 feet by 2 feet discharges through the dam over an inclosed weir. There is no information as to the form of construction where this goes through the core wall (if any) of how it is protected through the earth fill. There is also a 12 inch iron pipe with gate, which Mr. Emerson says is not in use. The water shed is 315 acres according to second report of Water Sup. Com - 1903. The dam is low and wide on the top so that it would stand a considerable wash over top and discharge would be immediately into the lower pond.

As area of pond is about 64 acres, a 6" rain in 24 hours would raise level not much over 2 feet. There is 5 feet difference in level between the two ponds and under this head a 2' x 2' flume would discharge more than one half this amount in the 24 hours. Provided it be clear and weir regulated to permit it. This pond can be filled also from a 24" pipe which comes from Suntaug Lake to the Pumping station with a branch to Spring pond.

1923 Report to Co. Comm. The dam immediately next up stream (from Fountain Pond) known as Spring Pond Dam is in fairly good condition but depends for a wasteway upon a wooden flume only a part of which is visible and which discharges over a weir located in a house, controlling the height of water in the pond above. This upper pond is only some five feet higher than the lower pond and the earth dam is of considerable width so that it would probably stand some washing over the top. The capacity of the wooden flume is somewhat uncertain but is probably sufficient to take care of flood conditions unless the pond level be fixed too high.

Practically the same statement applies to the dam at Brown's pond the outlet of which finds its way into the Tapley Brook. The dam is in good condition and the spillway sufficient provided the stop plank be so regulated as to keep the pond at a safe level in anticipation of floods.

In view of these conditions I would recommend that if it be within your powers under the law an understanding be arrived at with the owners of these and other similar dams as to the control of such stop plank or flash boards and a definite height be fixed in each case, above which no such obstruction to the flow of the water may under any circumstances be placed, as the safety of the dam in many cases depends largely or entirely on this. Reliance for safety on removal of stop plank or opening of gates or any other means involving the human element is at best a precaution far inferior to the providing of a wasteway of sufficient width to automatically discharge all possible floods without unduly raising the pond level, and if allowed at all should be safeguarded as far as possible.

1928, July 26. C. C. Barker, Insp. Dam at the north end of Spring Pond, east of Lynn Street, is owned by the Peabody Water Works, and is part of their water supply system. I gave a copy of the notice to Mr. Mosher, City Engineer, who had Mr. O'Donnell, inspector, accompany me to the dam. In case of failure, the water would merely flow into the lower basin and probably the only damage would be to the dam itself. The conditions are the same as at the last inspection, but the old 2' x 2'

Peabody D. 12

wooden box which leads from the pond to the gate house broke and was replaced by a 30" pipe in 1927. The dam is in fair condition, and the walls at the outlet and gate house are in good condition. There is some brush on the paved slopes on the upper side which should be cut. The water level today is five feet below the top of the dam. There should be a good spillway on this pond to take care of the over-flow automatically.

1928, Nov. 22. R. R. Evans, Insp. notes of Dams in Peabody which see.

1928 Report to Co. Comm. At Spring Pond there is a dam between that pond and the pond just below which is in good condition and the outlets, if all opened to capacity in time would probably take care of any storms ordinarily to be expected and apparently some overflow in excess of the capacity of these outlets might occur over the dam and in the low lands to the west without serious damage.

C. C. Barker, Insp.

1930, Sept. 11. Dam at the north end of Spring Pond, east of Lynn St., is owned by the Peabody Water Works, and is part of their water supply system. I gave a copy of the notice to R. W. MacDonald, City Engineer, but he did not send anyone to the dam with me. In case of failure, the water would fill the lower basin and might do damage to the dam downstream. There are a great many bushes on the upper slope which should be removed. On lower side of the dam at the westerly side of the outlet, the earth has slumped. The dam is in fair condition, and there have been no changes since the last inspection. The water level today is about 6 feet below the top of the dam.

1930, Nov. 20. R. R. Evans, Insp. No particular examination made - no particular comment.

1930 Report to Co. Comm. The dam at the north end of Spring Pond which forms a part of the Peabody water supply system is of some importance from the fact that a failure might produce failure in other dams below it on the same stream. It is apparently safe and in good condition.

1932, July 28. C. C. Barker, Insp. The condition is the same and there has been no change. There is still a slump in the paving on the upper slope along the outlet pipe and a slump in the earth west of outlet on down stream slope. The pond is very low.

1933, See Report to Co. Comm.

1934, Sept. 26. C. C. Barker, Insp. This dam is in good condition except that few bushes on the upper slopes should be cut, also there is still a slump in the paving on the upper slope along the outlet pipe also around the spillway walls on the lower side. The chamber into which the 24 inch overflow pipe from Spring Pond emptied has been filled with earth. If I understand Mr. McNeal correctly there is no outlet from Spring Pond now except through the spillway, the height of which is controlled by stop plank which can be placed to the top of the dam. This is not a very good condition. The pipe from Brown's pond leads to a man hole and then is carried direct to below the Fountain Pond Dam at the pumping station. There is no connection now between Brown and Spring Ponds.

Peabody D. 12

1934 Report to Co. Comm. See D. 5

1936 August 30, C.C.Barker, Insp. Joseph Dullea went to the dam with me. The pond is low the water level is about 7.5 feet below the top. There are some bushes on the upper slope. There is still a slump in the upper slope along the outlet pipe and around the lower side of the spillway outlet walls. Otherwise dam is in good condition. No repairs have been made since the last inspection.

1936 Report to Co. Comm. See D. 5

1938 October 19, C.C.Barker, Insp. There are some bushes on the upper slope. The dam is in the same condition as when last inspected. No repairs have been made. The water level is about 4 feet below the top of the dam.

1938 Report to Co. Comm. See D. 7A.

1940 Sept. 27, C.C.Barker, Insp. No repairs on this dam have been made since the last inspection and its condition is about the same. There are many bushes on the upper slope. There is a crack in the gate house over the easterly spillway wall, which shows there is settlement in the embankment east of the spillway. The water level is about 5.5 feet below the top of the dam.

1940 Report to Co. Comm. See D. 7A.

1942 July 23, C.C.Barker, Insp. Since the last inspection an eight inch pipe has been laid about 2 1/2 feet deep through the dam just west of the gate house. This was used to carry the water into the basin below the dam when Spring Pond was low and it was necessary to pump the water from Spring Pond. No repairs have been made and the condition of the dam is the same as when last inspected. The water is about 5.5 feet below the top of the dam.

1942 Report to Co. Comm. See D. 7A.

1944 July 3, S.W.Woodbury, Insp. I left a copy of the notice for Mr. McCarthy, Supt., but went to the dam alone. The water level is about 6 ft. below the top of the dam. A large gravel pit has been excavated just west of the pond and very close to it which leaves a dike standing which is only about two ft. wide on top and about 2 1/2 ft. higher than the water level today. The water level in the gravel pit is about the same as the pond. The 8" C.I. pipe is about 3 ft. above the water level today, so if the water rises in the pond it will without question overflow the gravel pit before it reaches the 8 in. pipe. The gravel pit is about 500 ft. square and extends to the road. The slump in the upper looks as if it might be the same as previously reported.

1944 Report to Co. Comm. Safe and in reasonably good condition.

1946 Aug. 2, S.W.Woodbury, Insp. I gave a copy of the notice to Mr. Thomas Harte (Chief Eng.) for Frank McCarthy, Comm. of P.W. Mr. Harte went to the dam with me. Water level today is 4 ft. below top of dam. The outlet pipe is about half full of gravel. The rainfall during the term of Dec. 7, 1945 was 3.76", but there was practically no damage here.

Peabody D. 12

1946 Report to Co. Comm. Safe and in reasonably good condition.

1948 Sept. 15, S. W. Woodbury, Insp. Gave a copy of the notice to Mr. Thomas Harte for Mr. McCarthy and went to dam alone. Water level today: 5 ft. below top of dam.

1948 Report to Co. Comm. Safe and in reasonably good condition.

1950 Sept. 18, S.W. Woodbury, Insp. Gave a copy of the notice to Mr. John Manning for Mr. McCarthy and went to dam alone. Water level today: 6.5' below top of dam.

1950 Report to Co. Comm. Safe and in reasonably good condition.

1952 Sept. 30, E.H. Page, Insp. Left a copy of the notice at office of Com. of Public Works and went to dam with Mr. Driscoll from the pumping station. No repairs since last inspection. Water level today: 6.0 below top of dam. Condition of the dam is the same.

1952 Report to Co. Comm. Safe and in reasonably good condition.

1954, June 2, E.H. Page, Insp. Elev. of water: 1" below top of flashboards. Height of flashboards: 4' +. est. Obstructions: Clear. Some erosion of banks near gate house downstream. Overtopping at the road. A low gravel windrow has been placed along side of road to keep water from washing over road.

1954 Report to Co. Comm. At the north end of Spring Road, east Lynn Street, at the time of the inspection, the water was higher than the road low windrow of gravel had been placed along the road to keep the water from shing over the road.

1956, Sept. 7, E.H. Page, Insp. Slope paving at gatehouse has settled.

1956 Report to Co. Comm. At the north end of Spring Pond, east of Lynn Street, the slope paving has settled at the gatehouse.

1958, May 19, E.H. Page, Insp. They have been dredging both sides of the dam. No activity today. There are two pieces of equipment standing in 2'± of water, a crane and endless belt dredge.

1959, Jan. 5, E.H. Page & K.M. Jackson. They have done a lot of dredging here.

1958, Report to Co. Comm. At the north end of Spring Pond, east of Lynn Street, the slope paving has settled at the gatehouse. The brook leading from the pond to the pumping station has been widened and dredged considerably. Excavation is also completed to eliminate the shallow areas of the pond to increase the storage capacity. A huge pile of gravel that was removed from the pond remains in the north end of the pond west of the spillway.

ody D. 12

D. 12 Sh. 5

1961, January 5, E.H.Page & P.D.Killam, Insps. Condition: Same.
el pile gone.

1960 Report to Co. Comm. At the north end of Spring Pond, east of
Street, the slope paving has settled at the gatehouse. The pile of
el in the north end of the pond has been removed for the most part.

1962 Dec. 28, K.M.Jackson, Insp. Owner: City of Peabody, (Water Works)
ition: Same. Frozen. There has been some grouting done on paving in
t of gate. Slope paving is settled about 12 feet east of gate house.
some weeks and small brush growing up out of paving, should be removed.

1962 Report to Co. Comm. At the north end of Spring Pond, east of Lynn
et, there has been some grouting done to the slope paving in front of
e house. The paving is settling about twelve feet east of the gate house.
weeds and small brush growing out of paving should be removed.

1964 March 9, 1965. P.D.K. & K.M.J. Insps. Paving has been reset,
ted and bushes and small growth removed.

1964. Report to Co. Comm. There has been some grouting done to the
e paving in front of gate house. Weeds and small brush growing out of
ing have been removed.

1966 March 4, 1967. P D.K. & K.M.J. Insps. Paving has been reset,
ted and bushes and small growth removed.

1966 Report to Co. Comm. Safe and in reasonably good condition.

1968. Feb. 6, 1969. P.D.Killam. The gatehouse here is gone and the
a is covered with steel plates. Unable to measure flow.

2

D. 12

PEABODY

5-5-229-12

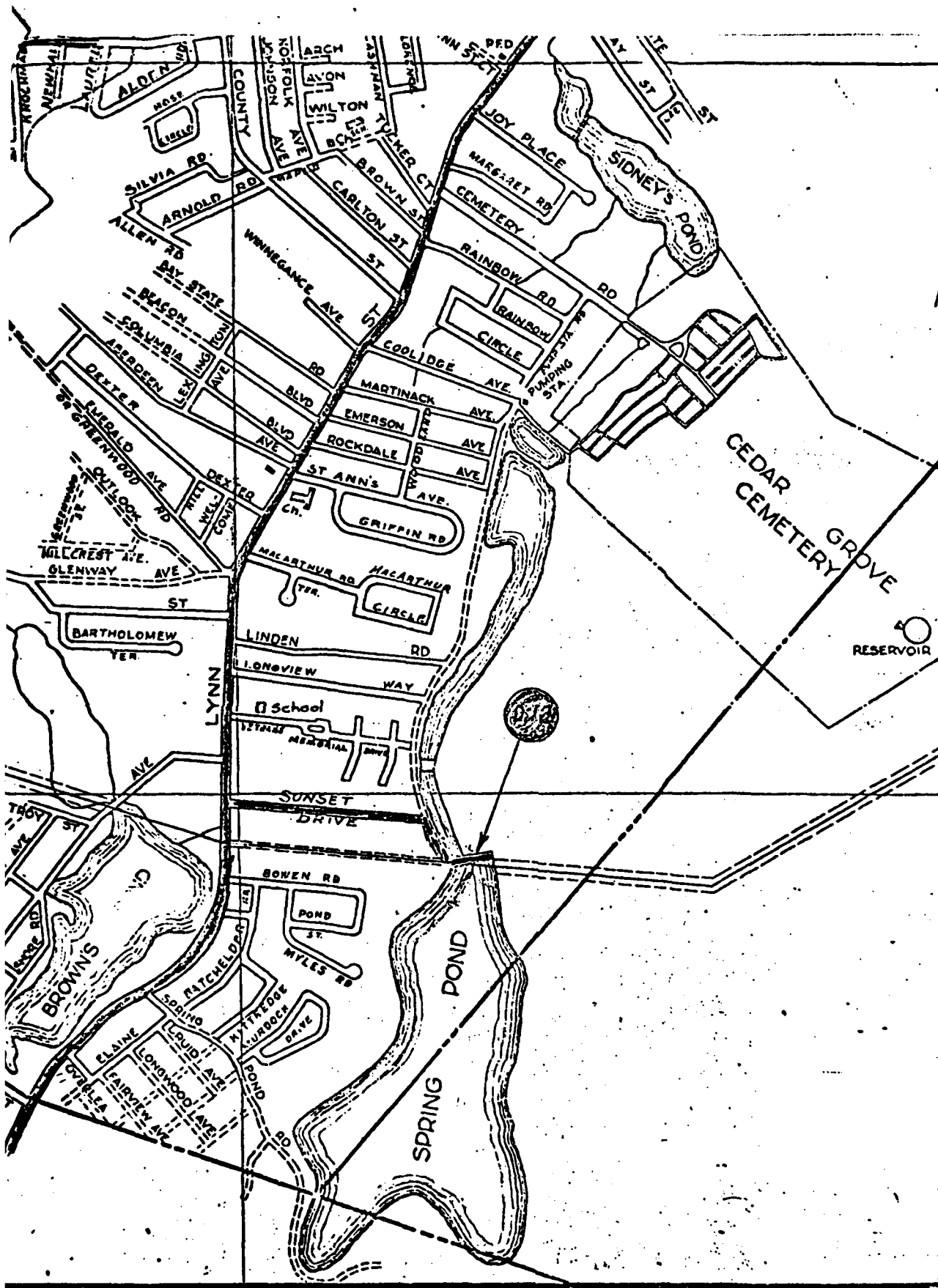
L.E. WILKINSON

11/30/71

ON TAPLEY BROOK OUTLET OF SPRING POND - TAKE
SUNSET DRIVE AT LYNN ST. GO 0.25 MI. EAST AND THEN 200.0 FT.
SOUTH TO DAM.

CITY OF PEABODY
WATER SUPPLY

WATER LEVEL OF POND $8.0 \pm$ FEET
BELOW TOP OF DAM. WATER FLOWING THROUGH SPILLWAY
ABOUT 4" DEEP.



PHOTOGRAPHS

APPENDIX C

CALCULATED RUNOFF (CFS)

APPLIED TO MICROGRAPH NO. 1

TIME	FLOW	TIME	FLOW	TIME	FLOW	TIME	FLOW	TIME	FLOW	TIME	FLOW	TIME	FLOW	TIME	FLOW
0.00	0.00	0.08	0.00	0.16	0.00	0.25	0.00	0.33	0.00	0.41	0.00	0.50	0.00	0.58	0.00
0.50	0.00	0.58	0.00	0.66	0.00	0.75	0.00	0.83	0.00	0.91	0.00	1.00	0.00	1.08	0.00
1.00	0.00	1.08	0.00	1.16	0.00	1.25	0.00	1.33	0.00	1.41	0.00	1.50	0.00	1.58	0.00
1.50	0.00	1.58	0.00	1.66	0.00	1.75	0.00	1.83	0.00	1.91	0.00	2.00	0.00	2.08	0.00
2.00	0.00	2.08	0.00	2.16	0.00	2.25	0.00	2.33	0.00	2.41	0.00	2.50	0.00	2.58	0.00
2.50	0.00	2.58	0.00	2.66	0.00	2.75	0.00	2.83	0.00	2.91	0.00	3.00	0.00	3.08	0.00
3.00	0.00	3.08	0.00	3.16	0.00	3.25	0.00	3.33	0.00	3.41	0.00	3.50	0.00	3.58	0.00
3.50	0.00	3.58	0.00	3.66	0.00	3.75	0.00	3.83	0.00	3.91	0.00	4.00	0.00	4.08	0.00
4.00	0.00	4.08	0.00	4.16	0.00	4.25	0.00	4.33	0.00	4.41	0.00	4.50	0.00	4.58	0.00
4.50	0.00	4.58	0.00	4.66	0.00	4.75	0.00	4.83	0.00	4.91	0.00	5.00	0.00	5.08	0.00
5.00	0.00	5.08	0.00	5.16	0.00	5.25	0.00	5.33	0.00	5.41	0.00	5.50	0.00	5.58	0.00
5.50	0.00	5.58	0.00	5.66	0.00	5.75	0.00	5.83	0.00	5.91	0.00	6.00	0.00	6.08	0.00
6.00	0.00	6.08	0.00	6.16	0.00	6.25	0.00	6.33	0.00	6.41	0.00	6.50	0.00	6.58	0.00
6.50	0.00	6.58	0.00	6.66	0.00	6.74	0.00	6.83	0.00	6.91	0.00	7.00	0.00	7.08	0.00
6.99	0.00	7.08	0.00	7.16	0.00	7.24	0.00	7.33	0.00	7.41	0.00	7.50	0.00	7.58	0.00
7.49	0.00	7.58	0.00	7.66	0.00	7.74	0.00	7.83	0.00	7.91	0.00				

TOTAL PRECIPITATION IN

TIME	PREC	TIME	PREC	TIME	PREC	TIME	PREC	TIME	PREC	TIME	PREC	TIME	PREC
0.08	0.09	0.16	0.09	0.25	0.09	0.33	0.09	0.41	0.10	0.50	0.10		
0.58	0.10	0.66	0.10	0.75	0.11	0.83	0.11	0.91	0.11	1.00	0.11		
1.08	0.17	1.16	0.17	1.25	0.17	1.33	0.17	1.41	0.17	1.50	0.17		
1.58	0.22	1.66	0.22	1.75	0.26	1.83	0.27	1.91	0.40	2.00	0.40		
2.08	0.41	2.16	0.41	2.25	0.56	2.33	0.57	2.41	0.64	2.50	0.64		
2.58	0.60	2.66	0.60	2.75	0.56	2.83	0.56	2.91	0.48	3.00	0.48		
3.08	0.41	3.16	0.41	3.25	0.41	3.33	0.34	3.41	0.34	3.50	0.34		
3.58	0.26	3.66	0.26	3.75	0.26	3.83	0.21	3.91	0.21	4.00	0.21		
4.08	0.18	4.16	0.18	4.25	0.18	4.33	0.18	4.41	0.15	4.50	0.15		
4.58	0.15	4.66	0.15	4.75	0.13	4.83	0.13	4.91	0.13	5.00	0.13		
5.08	0.13	5.16	0.13	5.25	0.13	5.33	0.13	5.41	0.13	5.50	0.13		
5.58	0.11	5.66	0.11	5.75	0.11	5.83	0.11	5.91	0.11	6.00	0.11		

THE TOT PREC FOR 6.00 HOURS= 17.77

PRECIPITATION EXCESS (IN)

APPLIED TO HYDROGRAPH NO. 1

TIME	PREC	TIME	PREC	TIME	PREC	TIME	PREC	TIME	PREC	TIME	PREC	TIME	PREC
0.08	0.09	0.16	0.09	0.25	0.09	0.33	0.09	0.41	0.10	0.50	0.10		
0.58	0.10	0.66	0.10	0.75	0.11	0.83	0.11	0.91	0.11	1.00	0.11		
1.08	0.17	1.16	0.17	1.25	0.17	1.33	0.17	1.41	0.17	1.50	0.17		
1.58	0.22	1.66	0.22	1.75	0.26	1.83	0.27	1.91	0.40	2.00	0.40		
2.08	0.41	2.16	0.41	2.25	0.56	2.33	0.57	2.41	0.64	2.50	0.64		
2.58	0.60	2.66	0.60	2.75	0.56	2.83	0.56	2.91	0.48	3.00	0.48		
3.08	0.41	3.16	0.41	3.25	0.41	3.33	0.34	3.41	0.34	3.50	0.34		
3.58	0.26	3.66	0.26	3.75	0.26	3.83	0.21	3.91	0.21	4.00	0.21		
4.08	0.18	4.16	0.18	4.25	0.18	4.33	0.18	4.41	0.15	4.50	0.15		
4.58	0.15	4.66	0.15	4.75	0.13	4.83	0.13	4.91	0.13	5.00	0.13		
5.08	0.13	5.16	0.13	5.25	0.13	5.33	0.13	5.41	0.13	5.50	0.13		
5.58	0.11	5.66	0.11	5.75	0.11	5.83	0.11	5.91	0.11	6.00	0.11		

THE TOT EXCESS PREC FOR 6.00 HOURS= 17.77

8

FLOW ORDINATES(CFS) FOR UNIT HYDROGRAPH 1

[illegible]

7

INFLOW HYDROGRAPH COMPUTATION

SPRING POND INFLOW HYDROGRAPH

TIME INTERVAL (HOURS)	LAKE AREA (ACRE)	NO. OF UNIT HYDS	PUNCH ACTION	TIME COEFF.	UNIT HYDROGRAPH LAG TIME MULTIPLE
0.083	280.0	1	YES	0.016	1
					2
					3
					4
					5

6

 * JOB NO..... 1497-14 *
 * DESCRIPTION.. SPRING POND INFLOW HYDROGRAPH *
 * USER NAME.... DOW *
 * DATE..... 11/15/78 *
 * PMF *

5

TOTAL RUN-OFF LAKE AREA RUN-OFF CONTRIBUTIONS BY HYDROGRAPH

TIME (HOURS)	TOTAL RUN-OFF COMPUTED (CFS)	LAKE AREA RUN-OFF (CFS)	1 (CFS)	2 (CFS)	3 (CFS)	4 (CFS)	5 (CFS)
4.166	166.6	166.6	0.0	0.0	0.0	0.0	0.0
4.250	166.6	166.6	0.0	0.0	0.0	0.0	0.0
4.333	165.4	165.4	0.0	0.0	0.0	0.0	0.0
4.416	138.0	138.0	0.0	0.0	0.0	0.0	0.0
4.500	138.0	138.0	0.0	0.0	0.0	0.0	0.0
4.583	138.0	138.0	0.0	0.0	0.0	0.0	0.0
4.666	138.0	138.0	0.0	0.0	0.0	0.0	0.0
4.750	122.5	122.5	0.0	0.0	0.0	0.0	0.0
4.833	121.9	121.9	0.0	0.0	0.0	0.0	0.0
4.916	121.9	121.9	0.0	0.0	0.0	0.0	0.0
5.000	121.9	121.9	0.0	0.0	0.0	0.0	0.0
5.083	118.0	118.0	0.0	0.0	0.0	0.0	0.0
5.166	118.0	118.0	0.0	0.0	0.0	0.0	0.0
5.250	118.0	118.0	0.0	0.0	0.0	0.0	0.0
5.333	118.0	118.0	0.0	0.0	0.0	0.0	0.0
5.416	118.0	118.0	0.0	0.0	0.0	0.0	0.0
5.500	118.0	118.0	0.0	0.0	0.0	0.0	0.0
5.583	107.2	107.2	0.0	0.0	0.0	0.0	0.0
5.666	107.2	107.2	0.0	0.0	0.0	0.0	0.0
5.750	107.2	107.2	0.0	0.0	0.0	0.0	0.0
5.833	107.2	107.2	0.0	0.0	0.0	0.0	0.0
5.916	107.2	107.2	0.0	0.0	0.0	0.0	0.0
6.000	107.2	107.2	0.0	0.0	0.0	0.0	0.0
6.083	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.166	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.250	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.333	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.416	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.499	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.583	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.666	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.749	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.833	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.916	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.999	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.083	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.166	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.249	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.333	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.416	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.499	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.583	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.666	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.749	0.0	0.0	0.0	0.0	0.0	0.0	0.0

----- RUN-OFF CONTRIBUTIONS BY HYDROGRAPH -----

TIME (HOURS)	TOTAL RUN-OFF		LAKE AREA		RUN-OFF CONTRIBUTIONS BY HYDROGRAPH				
	COMPUTED (CFS)	1	2	3	4	5	6	7	8
0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.083	85.3	85.3	85.3	0.0	0.0	0.0	0.0	0.0	0.0
0.166	85.3	85.3	85.3	0.0	0.0	0.0	0.0	0.0	0.0
0.250	85.3	85.3	85.3	0.0	0.0	0.0	0.0	0.0	0.0
0.333	85.8	85.8	85.8	0.0	0.0	0.0	0.0	0.0	0.0
0.416	98.6	98.6	98.6	0.0	0.0	0.0	0.0	0.0	0.0
0.500	98.6	98.6	98.6	0.0	0.0	0.0	0.0	0.0	0.0
0.583	98.6	98.6	98.6	0.0	0.0	0.0	0.0	0.0	0.0
0.666	98.6	98.6	98.6	0.0	0.0	0.0	0.0	0.0	0.0
0.750	101.4	101.4	101.4	0.0	0.0	0.0	0.0	0.0	0.0
0.833	101.5	101.5	101.5	0.0	0.0	0.0	0.0	0.0	0.0
0.916	101.5	101.5	101.5	0.0	0.0	0.0	0.0	0.0	0.0
1.000	101.5	101.5	101.5	0.0	0.0	0.0	0.0	0.0	0.0
1.083	155.5	155.5	155.5	0.0	0.0	0.0	0.0	0.0	0.0
1.166	155.5	155.5	155.5	0.0	0.0	0.0	0.0	0.0	0.0
1.250	155.5	155.5	155.5	0.0	0.0	0.0	0.0	0.0	0.0
1.333	155.5	155.5	155.5	0.0	0.0	0.0	0.0	0.0	0.0
1.416	155.5	155.5	155.5	0.0	0.0	0.0	0.0	0.0	0.0
1.500	155.5	155.5	155.5	0.0	0.0	0.0	0.0	0.0	0.0
1.583	205.1	205.1	205.1	0.0	0.0	0.0	0.0	0.0	0.0
1.666	205.1	205.1	205.1	0.0	0.0	0.0	0.0	0.0	0.0
1.750	241.5	241.5	241.5	0.0	0.0	0.0	0.0	0.0	0.0
1.833	247.8	247.8	247.8	0.0	0.0	0.0	0.0	0.0	0.0
1.916	362.8	362.8	362.8	0.0	0.0	0.0	0.0	0.0	0.0
2.000	362.8	362.8	362.8	0.0	0.0	0.0	0.0	0.0	0.0
2.083	378.6	378.6	378.6	0.0	0.0	0.0	0.0	0.0	0.0
2.166	378.6	378.6	378.6	0.0	0.0	0.0	0.0	0.0	0.0
2.250	514.0	514.0	514.0	0.0	0.0	0.0	0.0	0.0	0.0
2.333	522.2	522.2	522.2	0.0	0.0	0.0	0.0	0.0	0.0
2.416	583.7	583.7	583.7	0.0	0.0	0.0	0.0	0.0	0.0
2.500	583.7	583.7	583.7	0.0	0.0	0.0	0.0	0.0	0.0
2.583	544.3	544.3	544.3	0.0	0.0	0.0	0.0	0.0	0.0
2.666	544.3	544.3	544.3	0.0	0.0	0.0	0.0	0.0	0.0
2.750	512.6	512.6	512.6	0.0	0.0	0.0	0.0	0.0	0.0
2.833	508.5	508.5	508.5	0.0	0.0	0.0	0.0	0.0	0.0
2.916	441.7	441.7	441.7	0.0	0.0	0.0	0.0	0.0	0.0
3.000	441.7	441.7	441.7	0.0	0.0	0.0	0.0	0.0	0.0
3.083	375.5	375.5	375.5	0.0	0.0	0.0	0.0	0.0	0.0
3.166	375.5	375.5	375.5	0.0	0.0	0.0	0.0	0.0	0.0
3.250	375.5	375.5	375.5	0.0	0.0	0.0	0.0	0.0	0.0
3.333	311.1	311.1	311.1	0.0	0.0	0.0	0.0	0.0	0.0
3.416	311.1	311.1	311.1	0.0	0.0	0.0	0.0	0.0	0.0
3.500	311.1	311.1	311.1	0.0	0.0	0.0	0.0	0.0	0.0
3.583	241.3	241.3	241.3	0.0	0.0	0.0	0.0	0.0	0.0
3.666	241.3	241.3	241.3	0.0	0.0	0.0	0.0	0.0	0.0
3.750	241.3	241.3	241.3	0.0	0.0	0.0	0.0	0.0	0.0
3.833	198.4	198.4	198.4	0.0	0.0	0.0	0.0	0.0	0.0
3.916	198.4	198.4	198.4	0.0	0.0	0.0	0.0	0.0	0.0
4.000	198.4	198.4	198.4	0.0	0.0	0.0	0.0	0.0	0.0
4.083	166.6	166.6	166.6	0.0	0.0	0.0	0.0	0.0	0.0

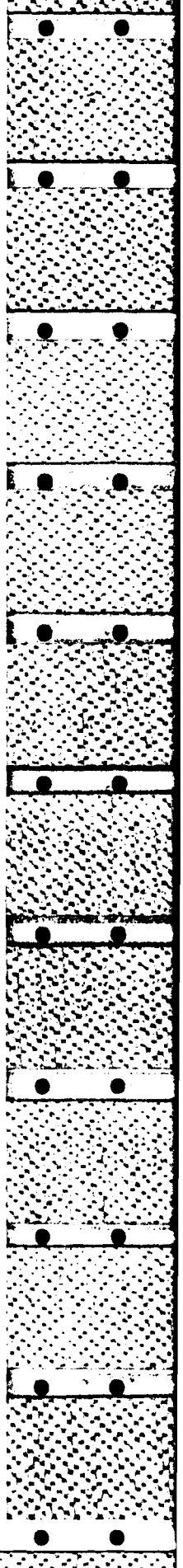
INELON HYDROGRAPH COMPUTATION

SPRING COND. INELON HYDROGRAPH

TIME INTERVAL (HOURS)	LAKE AREA (ACRES)	NO. OF UNIT PYDS	PUNCH OPTION	TIME COEFF.	UNIT HYDROGRAPH LAG TIME MULTIPLE
0.083	280.0	1	YES	0.016	1
ENG					

2

 * JOB NO..... 1497-14
 * DESCRIPTION.. SPRING POND INFLOW HYDROGRAPH
 * USER NAME..... DCX
 * DATE..... 11/15/78
 * 100-YR FLOOD

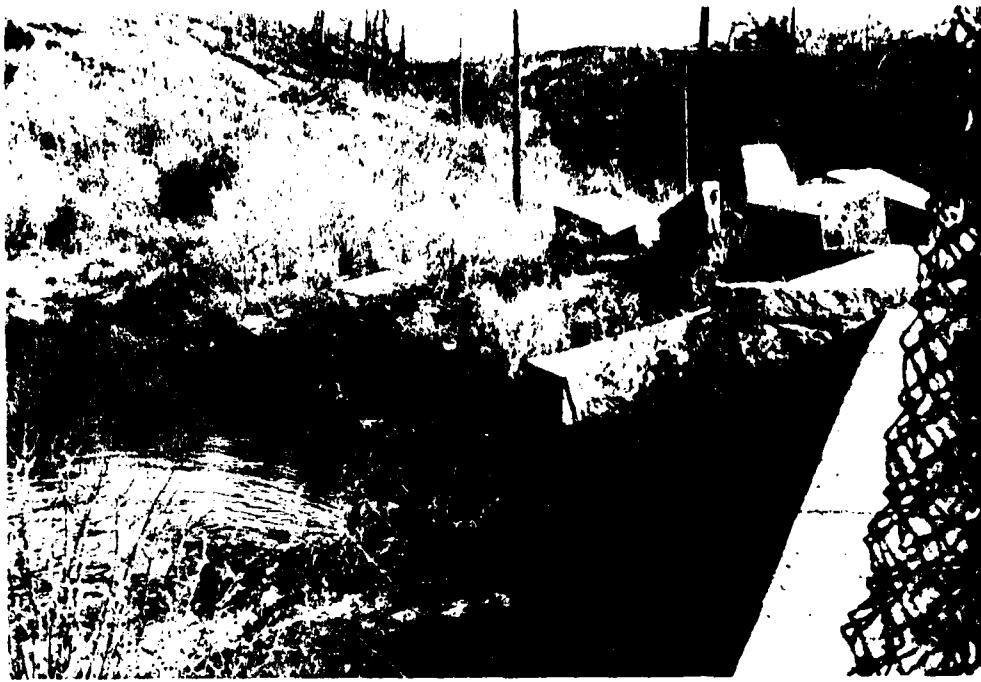




SPRING POND
WATERSHED

HYDROLOGIC DATA AND COMPUTATIONS

APPENDIX D



VIEW OF DOWNSTREAM SLOPE. NOTE VEGETATION.



VIEW OF SPILLWAY LOOKING UPSTREAM.

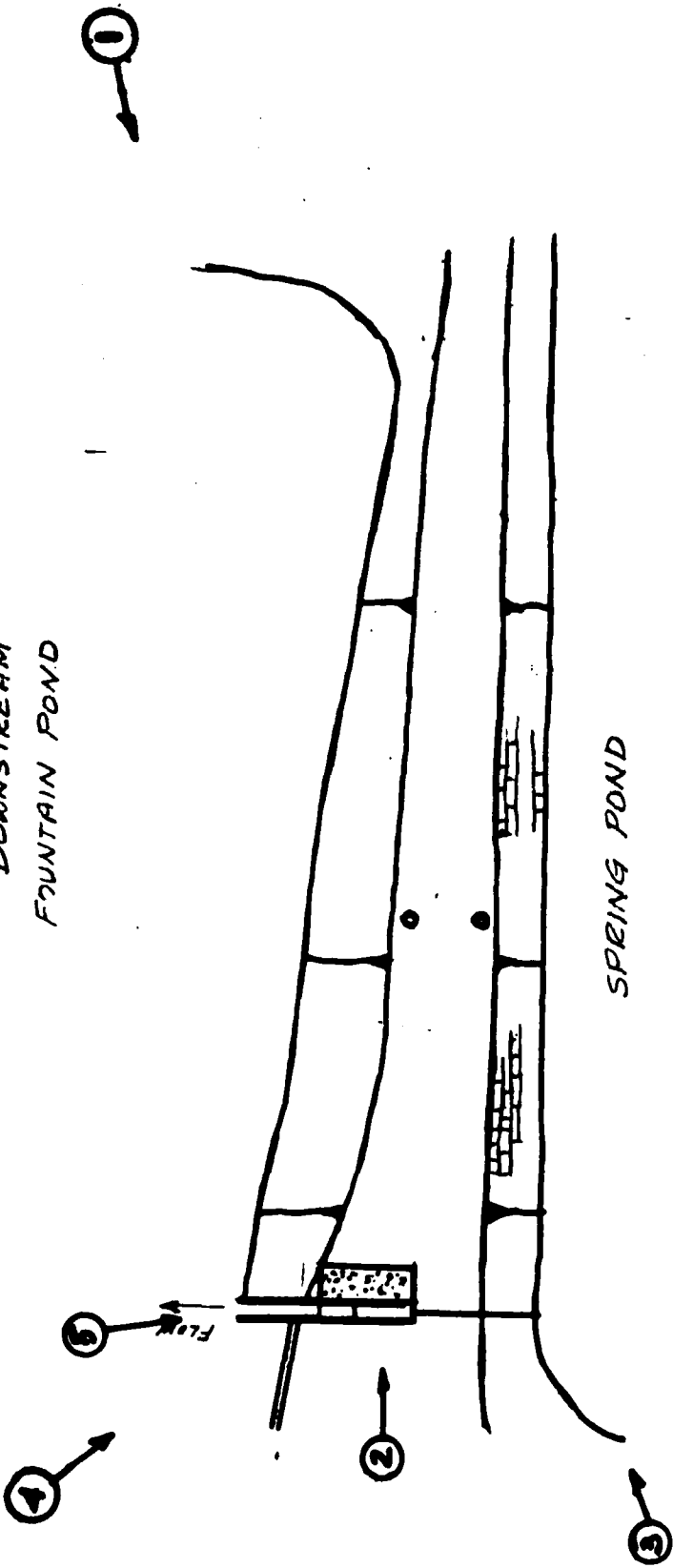


2. VIEW OF CREST. NOTE REMNANT OF GATE HOUSE IN FOREGROUND AND HIGH VOLTAGE TRANSMISSION TOWERS.



3. VIEW OF UPSTREAM SLOPE. NOTE CEMENTED STONE RIPRAP AND VEGETATION.

DOWNSTREAM
FOUNTAIN POND



BROOKLINE	TAMS	MASS	US ARMY ENGINEER DIV. FORT MONMOUTH CORPS OF ENGINEERS WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS			
SPRING POND DAM			
PHOTOGRAPH LOCATION GUIDE			
NORTH RIVER BASIN MASS			
Scale: NYS			

----- RUN-OFF CONTRIBUTIONS BY HYDROGRAPH -----

TIME (HOURS)	TOTAL RUN-OFF COMPUTED		LAKE AREA RUN-OFF		1		2		3		4		5	
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.063	319.4	319.4	319.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.166	319.4	319.4	319.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.250	319.4	319.4	319.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.333	321.4	321.4	321.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.416	369.1	369.1	369.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.500	369.1	369.1	369.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.583	369.1	369.1	369.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.666	369.1	369.1	369.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.750	379.8	379.8	379.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.833	380.2	380.2	380.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.916	380.2	380.2	380.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.000	380.2	380.2	380.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.083	582.3	582.3	582.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.166	582.3	582.3	582.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.250	582.3	582.3	582.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.333	582.3	582.3	582.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.416	582.3	582.3	582.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.500	582.3	582.3	582.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.583	767.7	767.7	767.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.666	767.7	767.7	767.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.750	904.1	904.1	904.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.833	927.8	927.8	927.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.916	1356.3	1356.3	1356.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.000	1358.3	1358.3	1358.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.083	1417.3	1417.3	1417.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.166	1417.3	1417.3	1417.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.250	1924.1	1924.1	1924.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.333	1954.8	1954.8	1954.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.416	2185.1	2185.1	2185.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.500	2185.1	2185.1	2185.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.583	2037.4	2037.4	2037.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.666	2037.4	2037.4	2037.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.750	1918.7	1918.7	1918.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.833	1903.4	1903.4	1903.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.916	1653.6	1653.6	1653.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.000	1653.5	1653.5	1653.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.083	1405.5	1405.5	1405.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.166	1405.5	1405.5	1405.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.250	1405.5	1405.5	1405.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.333	1164.6	1164.6	1164.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.416	1164.6	1164.6	1164.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.500	1164.5	1164.5	1164.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.583	903.5	903.5	903.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.666	903.5	903.5	903.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.750	903.5	903.5	903.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.833	742.9	742.9	742.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.916	742.9	742.9	742.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.000	742.9	742.9	742.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.083	623.6	623.6	623.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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TOTAL RUN-OFF LAKE AREA RUN-OFF CONTRIBUTIONS BY HYDROGRAPH

TIME (HOURS)	TOTAL RUN-OFF COMPUTED (CFS)	1 (CFS)	2 (CFS)	3 (CFS)	4 (CFS)	5 (CFS)
4.166	623.6	623.6	0.0	0.0	0.0	0.0
4.250	623.6	623.6	0.0	0.0	0.0	0.0
4.333	619.3	619.3	0.0	0.0	0.0	0.0
4.416	516.7	516.7	0.0	0.0	0.0	0.0
4.500	516.7	516.7	0.0	0.0	0.0	0.0
4.583	516.7	516.7	0.0	0.0	0.0	0.0
4.666	516.7	516.7	0.0	0.0	0.0	0.0
4.750	458.7	458.7	0.0	0.0	0.0	0.0
4.833	456.3	456.3	0.0	0.0	0.0	0.0
4.916	456.3	456.3	0.0	0.0	0.0	0.0
5.000	456.3	456.3	0.0	0.0	0.0	0.0
5.083	441.7	441.7	0.0	0.0	0.0	0.0
5.166	441.7	441.7	0.0	0.0	0.0	0.0
5.250	441.7	441.7	0.0	0.0	0.0	0.0
5.333	441.7	441.7	0.0	0.0	0.0	0.0
5.416	441.7	441.7	0.0	0.0	0.0	0.0
5.500	441.7	441.7	0.0	0.0	0.0	0.0
5.583	401.5	401.5	0.0	0.0	0.0	0.0
5.666	401.5	401.5	0.0	0.0	0.0	0.0
5.750	401.5	401.5	0.0	0.0	0.0	0.0
5.833	401.5	401.5	0.0	0.0	0.0	0.0
5.916	401.5	401.5	0.0	0.0	0.0	0.0
6.000	401.5	401.5	0.0	0.0	0.0	0.0
6.083	0.0	0.0	0.0	0.0	0.0	0.0
6.166	0.0	0.0	0.0	0.0	0.0	0.0
6.250	0.0	0.0	0.0	0.0	0.0	0.0
6.333	0.0	0.0	0.0	0.0	0.0	0.0
6.416	0.0	0.0	0.0	0.0	0.0	0.0
6.499	0.0	0.0	0.0	0.0	0.0	0.0
6.583	0.0	0.0	0.0	0.0	0.0	0.0
6.666	0.0	0.0	0.0	0.0	0.0	0.0
6.749	0.0	0.0	0.0	0.0	0.0	0.0
6.833	0.0	0.0	0.0	0.0	0.0	0.0
6.916	0.0	0.0	0.0	0.0	0.0	0.0
6.999	0.0	0.0	0.0	0.0	0.0	0.0
7.083	0.0	0.0	0.0	0.0	0.0	0.0
7.166	0.0	0.0	0.0	0.0	0.0	0.0
7.249	0.0	0.0	0.0	0.0	0.0	0.0
7.333	0.0	0.0	0.0	0.0	0.0	0.0
7.416	0.0	0.0	0.0	0.0	0.0	0.0
7.499	0.0	0.0	0.0	0.0	0.0	0.0
7.583	0.0	0.0	0.0	0.0	0.0	0.0
7.666	0.0	0.0	0.0	0.0	0.0	0.0
7.749	0.0	0.0	0.0	0.0	0.0	0.0

TAMS

Job No. 1497-10

Project SPRING POND

Subject FLOW THROUGH PIPE

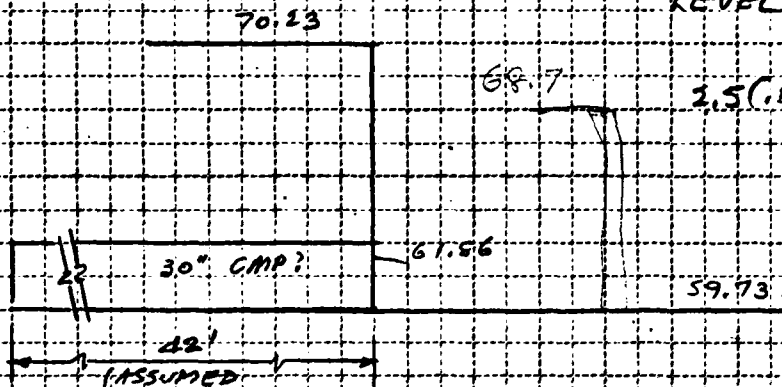
Sheet 12 of

Date

By

Ch'k. by

ASSUME FOUNTAIN POND
LEVEL AT 61.58



$$\begin{aligned} 2.5(1.05) &= 2.125 \\ 59.73 \\ \hline 61.855 \\ \text{USE } 61.86 \end{aligned}$$

EL	EL-61.86	Q (cfs)
66	4.14	56.4
68	6.14	68.7
68.7	6.84	72.5
70	8.14	79.1
70.23	8.37	80.2
72	10.14	88.3
74	12.14	96.6
76	14.14	104.3
78	16.14	111.4
80	18.14	118.1

$$H_f = \left[\frac{2.5204(1.5)}{2.5^4} + \frac{466.18(0.15)^2(42)}{2.5^{14.5}} \right] \frac{Q^2}{10^2}$$

$$H_f = [0.09678 + 0.03324] \frac{Q^2}{10^2}$$

$$Q = \sqrt{\frac{100 H}{.13}}$$

TAMS

Job No. 1497-14

Project _____

Subject SPRING POND

Flow over Dam

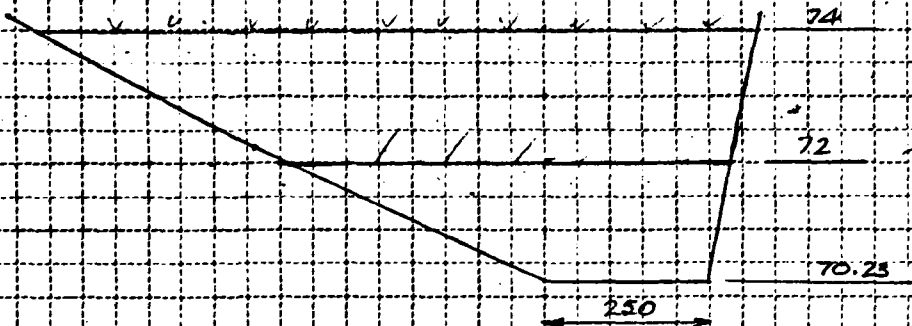
Sheet 13 of _____

Date 11/22/78

By CV

Ch'k. by _____

65
21
90



ELEV	L	ΔA	A	h	h^3	Q
70.23	250		0			
72	670	814.2	814.2	1.215	2.8	2512
74	1090	1760.0	2574.2	2.36	3.1	12263

ELEV	Q_p	Q_p	Q_{Σ}	Δ (ac ft)
68.7	0		0	418.3
70	79.1		79.1	508.8
70.23	80.2	0	80.2	525.0
72	85.3	2512	2600.3	651.0
74	96.6	12263	12359.6	796.1

SPRING POND PEABODY PASS.
 JOB NO. 1497-14 RESERVOIR ROUTING
 TAMS DAM SAFETY INSPECTION

100 YEAR

INPUT PARAMETERS

STARTING ELEV. (FT.)	TIME INTERVAL (HOURS)	STARTING TIME (HOURS)	ENDING TIME (HOURS)	PRINT INTERVAL (HOURS)	GATE OPTION	PLOT OPTION	STORAGE COEF.	OUTFLOW COEF.	INFLOW COEF.	TIME COEF.	BREAK TIME
68.70	0.50	0.00	7.74	1	NO	YES	1.000	1.000	1.000	1.000	0.000

RESERVOIR ELEV. (FT.)	RESERVOIR STORAGE (ACFT)	RESERVOIR OUTFLOW (CFS)
68.70	418.3000	0.00
70.00	508.8000	79.10
70.23	525.0001	80.20
72.00	651.0001	2600.30
74.00	796.1000	12359.60

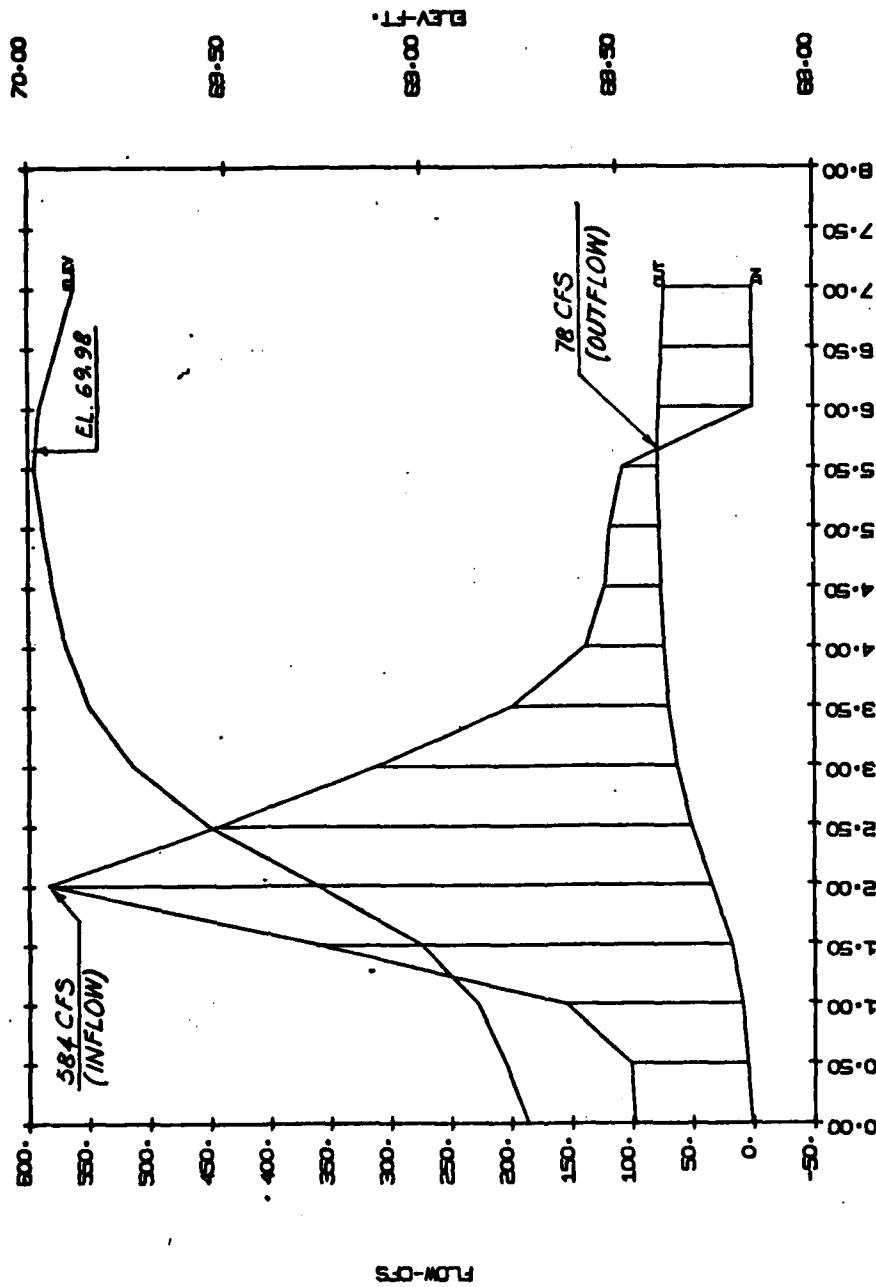
14

15

TIME (HRS)	INFLOW (CES)	OUTFLOW (CES)	STORAGE (ACE)	ELEVATION (FT.)
0.00	0.00		418.3000	68.70
0.50	98.60	1.74	420.3010	68.72
1.00	101.59	5.23	424.2927	68.78
1.50	155.56	9.61	429.2986	68.85
2.00	362.88	18.44	439.4290	69.00
2.50	583.76	34.80	457.8893	69.26
3.00	441.76	51.56	477.2954	69.54
3.50	311.12	63.08	490.4807	69.73
4.00	198.47	69.88	498.2613	69.84
4.50	138.05	73.37	502.2539	69.90
5.00	121.91	75.38	504.5511	69.93
5.50	118.01	76.96	506.3602	69.96
6.00	107.28	78.23	507.8084	69.98
6.50	0.00	77.36	506.8103	69.97
7.00	0.00	74.61	503.6706	69.92
7.50	0.00	71.96	500.6423	69.88

MAX. VALUES
MIN. VALUES

583.76 78.23 69.98
0.00 0.00 68.70



SPRING POND
100-YR FLOOD

TIME-HRS

FLOW-CFS

ELEV-FT.

SPRING POND, PEABODY MASS.
 JOB NO. 1497-14 RESERVOIR ROUTING
 TAMS DAM SAFETY INSPECTION

HALE PRE

INPUT PARAMETERS

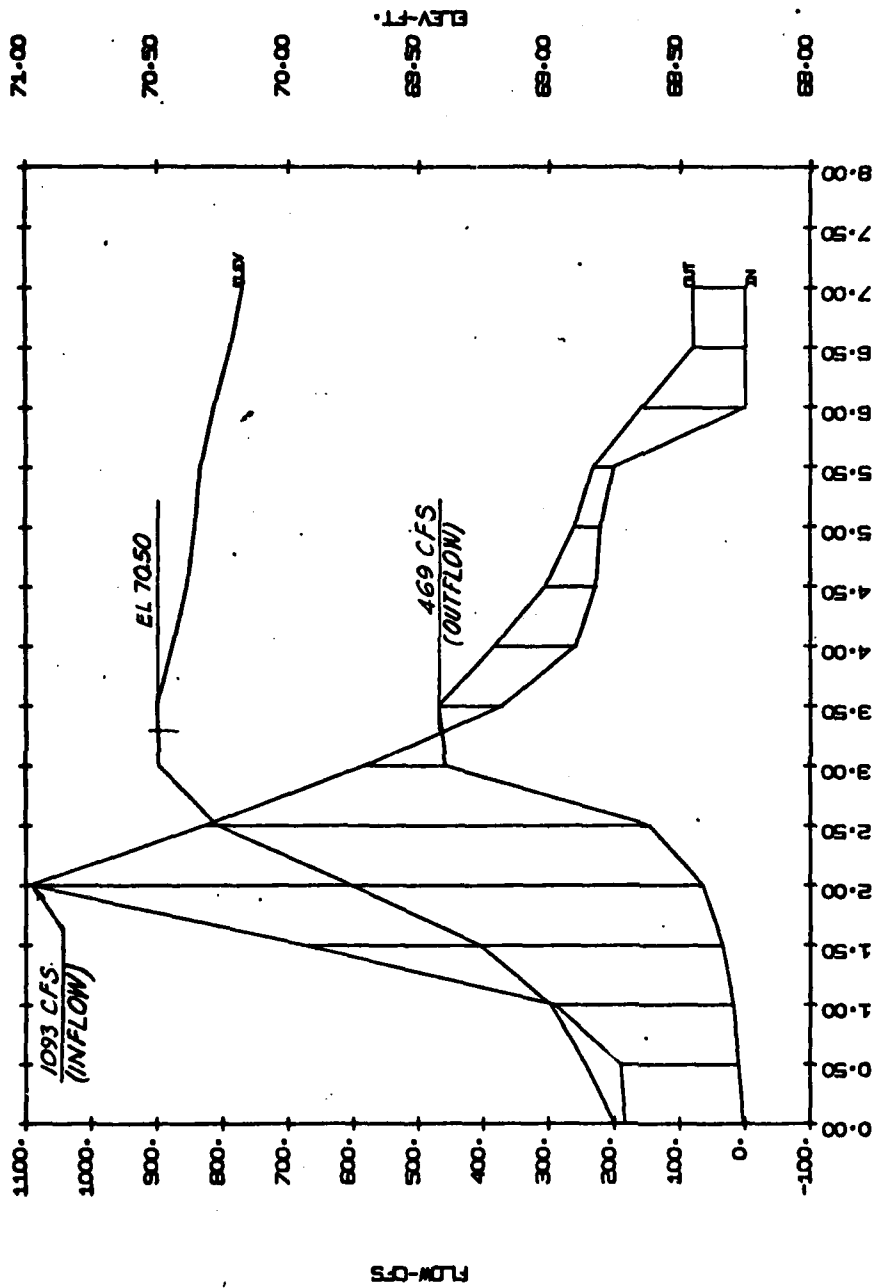
STARTING ELEV. (FT.)	TIME INTERVAL (HOURS)	STARTING TIME (HOURS)	ENDING TIME (HOURS)	PRINT INTERVAL (HOURS)	GATE OPTION	PLOT OPTION	STORAGE COEF.	OUTFLOW COEF.	INFLOW COEF.	TIME COEF.	BREAK TIME
68.70	0.50	0.00	7.74	1	NO	YES	1.000	1.000	0.500	1.000	0.000

RESERVOIR ELEV. (FT.)	RESERVOIR STORAGE (ACFT)	RESERVOIR OUTFLOW (CFS)
68.70	418.3000	0.00
70.00	508.8000	79.10
70.25	525.0001	80.20
72.00	651.0001	2600.30
74.00	796.1000	12359.60

17

18

TIME (HRS)	INFLOW (CES)	OUTFLOW (CES)	STORAGE (ACFT)	ELEVATION (FT.)
0.00	0.00		418.3000	68.70
0.50	184.55	3.27	422.0451	68.75
1.00	190.14	9.80	429.5159	68.86
1.50	291.15	17.99	438.8849	68.99
2.00	679.16	34.56	457.8449	69.26
2.50	1092.55	64.76	492.5947	69.76
3.00	826.79	147.19	528.3496	70.27
3.50	582.29	459.08	543.9436	70.49
4.00	371.46	469.04	544.415	70.50
4.50	258.37	382.79	540.1293	70.44
5.00	228.17	304.72	536.2257	70.38
5.50	220.87	259.84	533.9818	70.35
6.00	200.79	232.41	532.6105	70.33
6.50	0.00	158.53	528.9168	70.28
7.00	0.00	80.15	524.3375	70.22
7.50	0.00	79.93	521.0299	70.17
MAX. VALUES				
	1092.55	469.04		70.50
MIN. VALUES				
	0.00	0.00		68.70



SPRING POND
1/2 PMF

TIME-HRS

TAMS

1497-14

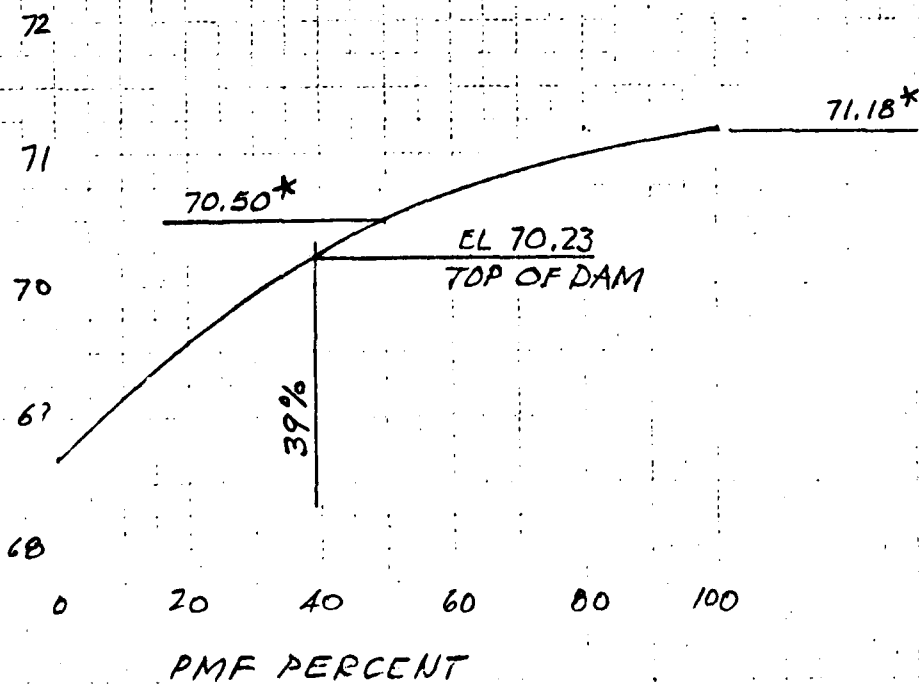
SPRING POND, MASS

Sheet 20 of

Date 11/28/78

By CV

Ch'k. by



* ELEVATIONS DETERMINED
BY FLOOD ROUTING

INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

APPENDIX E

END

FILMED

7-85

DTIC